Cloudera Runtime 7.2.7

Apache Hadoop YARN Reference

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Contents

Tuning Apache Hadoop YARN

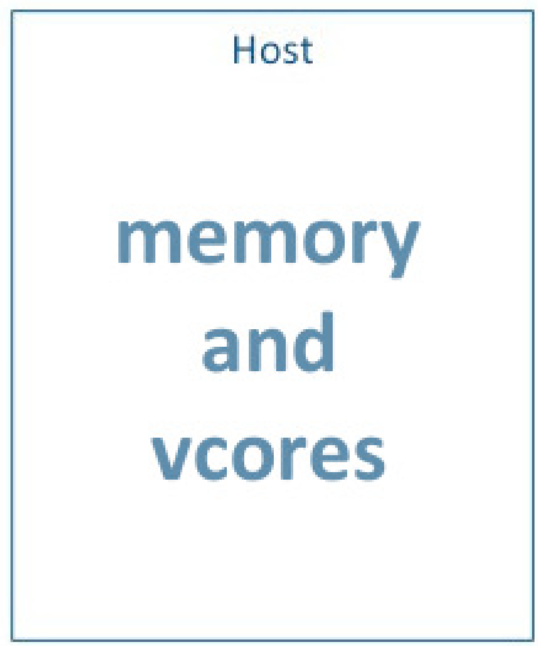
YARN tuning overview

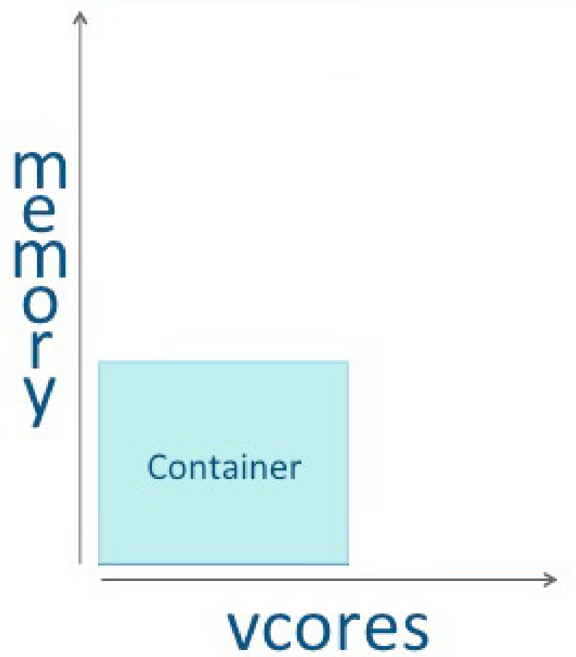
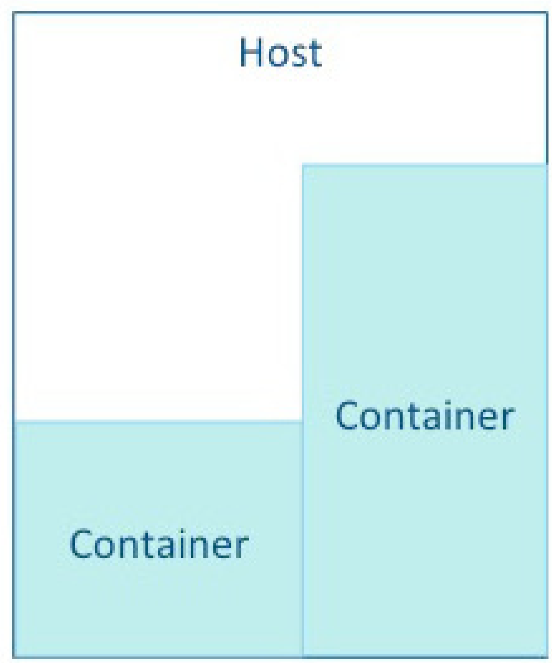
Abstract description of a YARN cluster and the goals of YARN tuning.

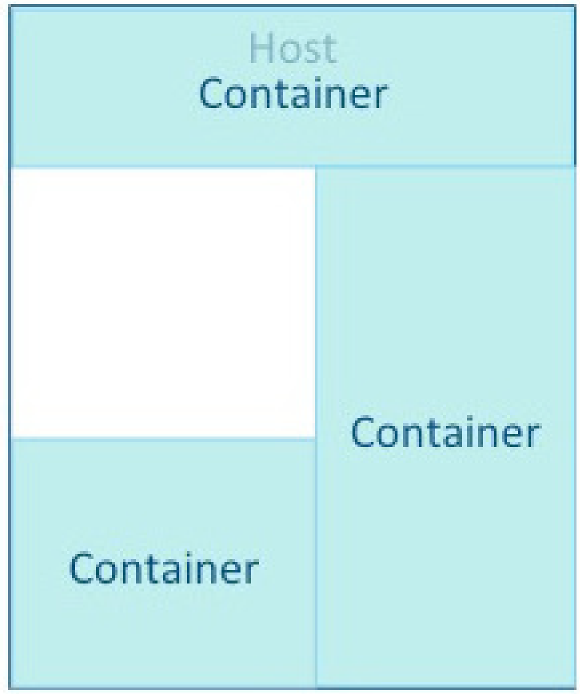
This topic applies to YARN clusters only, and describes how to tune and optimize YARN for your cluster.

Note: Download the Cloudera YARN tuning spreadsheet to help calculate YARN configurations. For a short video overview, see Tuning YARN Applications.

This overview provides an abstract description of a YARN cluster and the goals of YARN tuning.

A YARN cluster is composed of host machines. Hosts provide memory and CPU resources. A vcore, or virtual core, is a usage share of a host CPU.	

Tuning YARN consists primarily of optimally defining containers on your worker hosts. You can think of a container as a rectangular graph consisting of memory and vcores. Containers perform tasks.	
Some tasks use a great deal of memory, with minimal processing on a large volume of data.	

<table>
<tr>
<td>Other tasks require a great deal of processing power, but use less memory. For example, a Monte Carlo Simulation that evaluates many possible "what if?" scenarios uses a great deal of processing power on a relatively small dataset.</td>
<td>
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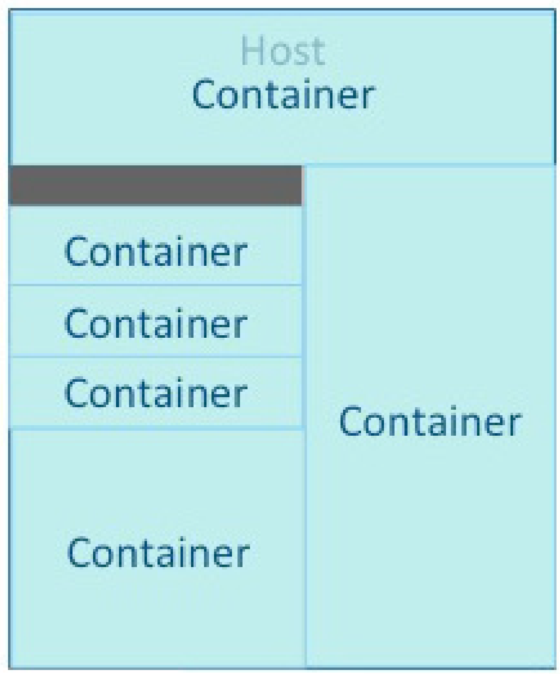
<td>The YARN ResourceManager allocates memory and vcores to use all available resources in the most efficient way possible. Ideally, few or no resources are left idle.</td>
<td>
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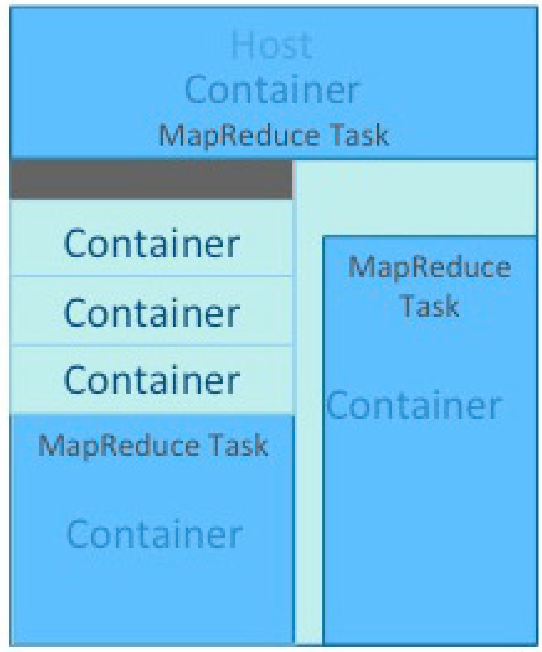
<tr>
<td>An application is a YARN client program consisting of one or more tasks. Typically, a task uses all of the available resources in the container. A task cannot consume more than its designated allocation, ensuring that it cannot use all of the host CPU cycles or exceed its memory allotment.</td>
<td>
</td>
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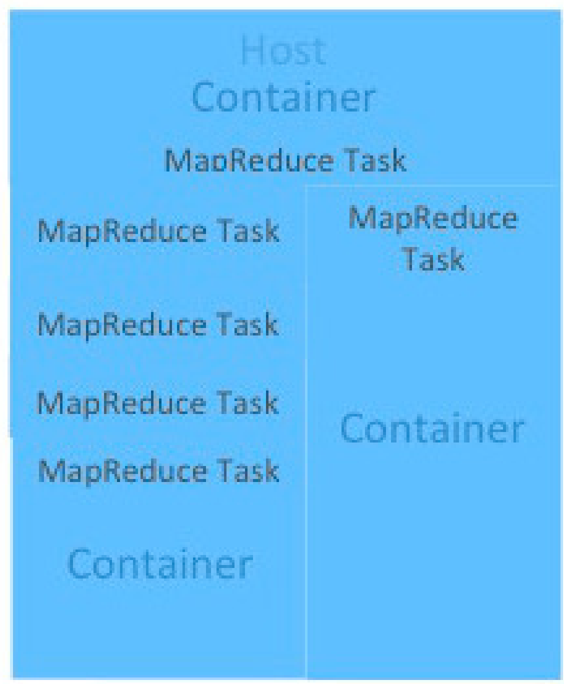
<tr>
<td>Tune your YARN hosts to optimize the use of vcores and memory by configuring your containers to use all available resources beyond those required for overhead and other services.</td>
<td>
</td>
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YARN tuning has three phases. The phases correspond to the tabs in the YARN tuning spreadsheet.

1. Cluster configuration, where you configure your hosts.
2. YARN configuration, where you quantify memory and vcores.
3. MapReduce configuration, where you allocate minimum and maximum resources for specific map and reduce tasks.

YARN and MapReduce have many configurable properties. The YARN tuning spreadsheet lists the essential subset of these properties that are most likely to improve performance for common MapReduce applications.

Step 1: Worker host configuration

Define the configuration for a single worker host computer in your cluster

Step 1 is to define the configuration for a single worker host computer in your cluster.

STEP 1: Worker Host Configuration

Enter your likely machine configuration in the input boxes below. If you are uncertain what machines you plan on buying, put in some minimum values that will suit what you expect to buy.

Host Components	Quantity	Size	Total	Description / Notes
RAM	256G		256G	Node memory in Gigabytes
CPU	4	6	48	Number of CPU's and the number of HW cores per CPU. The calculation of vcores below includes HyperThreading support.
HyperThreading CPU	yes			Does the CPU support HyperThreading?
HDD (Hard Disk Drive)	24	3T	72G	Number of Hard Drives and size per drive in JBOD Configuration
Ethernet	2	1G	2G	Number of Ethernet connections and the transfer speed

As with any system, the more memory and CPU resources available, the faster the cluster can process large amounts of data. A machine with 4 CPUs with HyperThreading, each with 6 cores, provides 48 vcores per host.

3 TB hard drives in a 2-unit server installation with 12 available slots in JBOD (Just a Bunch Of Disks) configuration is a reasonable balance of performance and pricing at the time the spreadsheet was created. The cost of storage decreases over time, so you might consider 4 TB disks. Larger disks are expensive and not required for all use cases.

Two 1-Gigabit Ethernet ports provide sufficient throughput at the time the spreadsheet was published, but 10-Gigabit Ethernet ports are an option where price is of less concern than speed.

Step 2: Worker host planning

Allocate resources on each worker machine,

STEP 2: Worker Host Planning

Now that you have your base Host configuration from Step 1, use the table below to allocate resources, mainly CPU and memory, to the various software components that run on the host.

Service	Category	CPU (cores)	Memory (MB)	Notes
Operating System	Overhead	1	8192	Most operating systems use 4-8GB minimum.
Other services	Overhead	0	0	Enter the required cores or memory for non CDH services not part of the OS.
Cloudera Manager agent	Overhead	1	1024	Allocate 1GB and 1 vcore for Cloudera Manager agents, which track resource usage on a host.
HDFS DataNode	CDH	1	1024	Allocation for the HDFS DataNode heap: default 1GB and 1 vcore.
YARN NodeManager	CDH	1	1024	Allocation for the YARN NodeManager heap: default 1GB and 1 vcore
Impala daemon	CDH	0	0	(Optional Service) Suggestion: Allocate at least 16GB memory when using Impala.
Hbase RegionServer	CDH	0	0	(Optional Service) Suggestion: Allocate no more than 12-16GB memory when using HBase Region Servers.
Solr Server	CDH	0	0	(Optional Service) Suggestion: Minimum 1GB for Solr server. More might be necessary depending on index sizes.
Kudu Server	CDH	0	0	(Optional Service) Suggestion: Minimum 1GB for Kudu Tablet server. More might be necessary depending on data sizes.
Available Container Resources		44	250880	
Container resources				
Physical Cores to Vcores Multiplier		1		Set this ratio based on the expected number of concurrent threads in a container per thread core. Default is 1.
YARN Available Vcores		44		This value will be used in STEP 4 for YARN Configuration
YARN Available Memory			250880	This value will be used in STEP 4 for YARN Configuration

Start with at least 8 GB for your operating system, and 1 GB for Cloudera Manager. If services outside of Cloudera Runtime require additional resources, add those numbers under Other Services.

The HDFS DataNode uses a minimum of 1 core and about 1 GB of memory. The same requirements apply to the YARN NodeManager.

The spreadsheet lists several optional services:

- Impala daemon requires at least 16 GB for the daemon.
- HBase Region Servers requires 12-16 GB of memory.
- Solr server requires a minimum of 1 GB of memory.
- Kudu Tablet server requires a minimum of 1 GB of memory.

Any remaining resources are available for YARN applications (Spark and MapReduce). In this example, 44 CPU cores are available. Set the multiplier for vcores you want on each physical core to calculate the total available vcores.

Step 3: Cluster size

Having defined the specifications for each host in your cluster, enter the number of worker hosts needed to support your business case.

To see the benefits of parallel computing, set the number of hosts to a minimum of 10.

STEP 3: Cluster Size

Enter the number of nodes you have (or expect to have) in the cluster

	Quantity
Number of Worker Hosts in the cluster	10

Steps 4 and 5: Verify settings

Verify the memory and vcore settings.

Step 4 pulls forward the memory and vcore numbers from step 2. Step 5 shows the total memory and vcores for the cluster.

STEP 4: YARN Configuration on Cluster

These are the first set of configuration values for your cluster. You can set these values in YARN->Configuration

YARN NodeManager Configuration Properties	Value	Note
yarn.nodemanager.resource.cpu-vcores	44	Copied from STEP 2 "Available Resources"
yarn.nodemanager.resource.memory-mb	250880	Copied from STEP 2 "Available Resources"

STEP 5: Verify YARN Settings on Cluster

Go to the Resource Manager Web UI (usually http://<ResourceManagerIP>:8088/ and verify the "Memory Total" and "Vcores Total" matches the values above. If your machine has no bad nodes, then the numbers should match exactly.

Resource Manager Property to Check	Value	Note
Expected Value for "Vcores Total"	440	Calculated from STEP 2 "YARN Available Vcores" and STEP 3
Expected Value for "Memory Total" (in GB)	2450	Calculated from STEP 2 "YARN Available Memory" and STEP 3

Step 6: Verify container settings on cluster

You can change the values that impact the size of your containers.

The minimum number of vcores should be 1. When additional vcores are required, adding 1 at a time should result in the most efficient allocation. Set the maximum number of vcore reservations to the size of the node.

Set the minimum and maximum reservations for memory. The increment should be the smallest amount that can impact performance. Here, the minimum is approximately 1 GB, the maximum is approximately 8 GB, and the increment is 512 MB.

STEP 6: Verify Container Settings on Cluster

In order to have YARN jobs run cleanly, you need to configure the container properties.

YARN Container Configuration Properties (Vcores)	Value	Description
yarn.scheduler.minimum-allocation-vcores	1	Minimum vcore reservation for a container
yarn.scheduler.maximum-allocation-vcores	44	Maximum vcore reservation for a container
yarn.scheduler.increment-allocation-vcores	1	Vcore allocations must be a multiple of this value

YARN Container Configuration Properties (Memory)	Value	Description
yarn.scheduler.minimum-allocation-mb	1024	Minimum memory reservation for a container in MegaByte
yarn.scheduler.maximum-allocation-mb	250880	Maximum memory reservation for a container in MegaByte
yarn.scheduler.increment-allocation-mb	512	Memory allocations must be a multiple of this value in MegaByte

Step 6A: Cluster container capacity

Validate the minimum and maximum number of containers in your cluster, based on the numbers you entered

Step 6A: Cluster Container Capacity

This section will tell you the capacity of your cluster (in terms of containers).

Cluster Container Estimates	Minimum	Maximum
Max possible number of containers, based on memory configuration		2450
Max possible number of containers, based on vcore configuration		440
Container number based on 2 containers per disk spindles		480
Min possible number of containers, based on memory configuration	10	
Min possible number of containers, based on vcore configuration	10	

Step 6B: Container sanity checking

See whether you have over-allocated resources.

STEP 6B: Container Sanity Checking

This section will do some basic checking of your container parameters in STEP 6 against the hosts.

Sanity Check	Check Status	Description
Scheduler maximum vcores must be larger than minimum	GOOD	yarn.scheduler.maximum-allocation-vcores >= yarn.scheduler.minimum-allocation-vcores
Scheduler maximum allocation MB must be larger than minimum	GOOD	yarn.scheduler.maximum-allocation-mb >= yarn.scheduler.minimum-allocation-mb
Scheduler minimum vcores must be greater than or equal to 0	GOOD	yarn.scheduler.minimum-allocation-vcores >= 0
Scheduler maximum vcores must be greater than or equal to 1	GOOD	yarn.scheduler.maximum-allocation-vcores >= 1
Host vcores must be larger than scheduler minimum vcores	GOOD	yarn.nodemanager.resource.cpu-vcores >= yarn.scheduler.minimum-allocation-vcores
Host vcores must be larger than scheduler maximum vcores	GOOD	yarn.nodemanager.resource.cpu-vcores >= yarn.scheduler.maximum-allocation-vcores
Host allocation MB must be larger than scheduler minimum	GOOD	yarn.nodemanager.resource.memory-mb >= yarn.scheduler.maximum-allocation-mb
Host allocation MB must be larger than scheduler maximum vcores	GOOD	yarn.nodemanager.resource.memory-mb >= yarn.scheduler.minimum-allocation-mb
Small container limit	GOOD	If yarn.scheduler.minimum-allocation-mb is less than 1GB, containers will likely get killed by YARN due to OutOfMemory issues

Step 7: MapReduce configuration

You can increase the memory allocation for the ApplicationMaster, map tasks, and reduce tasks.

The minimum vcore allocation for any task is always 1. The Spill/Sort memory allocation of 400 should be sufficient, and should be (rarely) increased if you determine that frequent spills to disk are hurting job performance.

The common MapReduce parameters mapreduce.map.java.opts, mapreduce.reduce.java.opts, and yarn.app.mapreduce.am.command-opts are configured for you automatically based on the *HEAP TO CONTAINER SIZE RATIO*.

STEP 7: MapReduce Configuration

For CDH 5.5 and later we recommend that only the heap or the container size is specified for map and reduce tasks. The value that is not specified will be calculated based on the setting mapreduce.job.heap.memory-mb.ratio. This calculation follows Cloudera Manager and calculates the heap size based on the ratio and the container size.

Application Master Configuration properties		Value	Description
yarn.app.mapreduce.am.resource.cpu-vcores		1	AM container vcore reservation
yarn.app.mapreduce.am.resource.mb		1024	AM container memory reservation in MegaByte
yarn.app.mapreduce.am.command-opts	-Xmx	800	AM Java heap size in MegaByte
Task auto heap sizing			
Use task auto heap sizing		yes	
mapreduce.job.heap.memory-mb.ratio		0.8	Ratio between the container size and task heap size.
Map Task Configuration properties			
mapreduce.map.cpu.vcores		1	Map task vcore reservation
mapreduce.map.memory.mb		1024	Map task memory reservation in MegaByte
mapreduce.map.java.opts	ignored	800	Map task Java heap size in MegaByte
mapreduce.task.io.sort.mb		400	Spill/Sort memory reservation
ReduceTask Configuration properties			
mapreduce.reduce.cpu.vcores		1	Reduce task vcore reservation
mapreduce.reduce.memory.mb		1024	Reduce task memory reservation in MegaByte
mapreduce.reduce.java.opts	ignored	800	Reduce Task Java heap size in MegaByte

Step 7A: MapReduce sanity checking

Verify at a glance that all of your minimum and maximum resource allocations are within the parameters you set.

STEP 7A: MapReduce Sanity Checking

Sanity check MapReduce settings against container minimum/maximum properties.

Application Master Sanity Checks	Value	Description
AM vcore request must fit within scheduler limits	GOOD	yarn.scheduler.minimum-allocation-vcores <= **yarn.app.mapreduce.am.resource.cpu-vcores** <= yarn-scheduler.maximum-allocation-vcores
AM memory request must fit within scheduler limits	GOOD	yarn.scheduler.minimum-allocation-mb <= **yarn.app.mapreduce.am.resource.cpu-vcores** <= yarn.scheduler.maximum-allocation-mb
Container size must large enough for java heap and overhead	GOOD	Java Heap should be between 75% and 90% of the container size: too low wastes resources, to high could lead to OOM
Ratio should be between 0.75 and 0.9	GOOD	Java Heap should be between 75% and 90% of the container size: too low wastes resources, to high could lead to OOM
Map Task Sanity Checks	**Value**	**Description**
Map task vcore request must fit within scheduler limits	GOOD	yarn.scheduler.minimum-allocation-vcores <= **mapreduce.map.cpu.vcores** <= yarn-scheduler.maximum-allocation-vcores
Map task memory request must fit within scheduler limits	GOOD	yarn.scheduler.minimum-allocation-mb <= **mapreduce.map.memory.mb** <= yarn.scheduler.maximum-allocation-mb
Container size must large enough for java heap and overhead	N/A	Java Heap should be between 75% and 90% of the container size: too low wastes resources, to high could lead to OOM
Spill/Sort memory should not use whole map task heap	GOOD	Make sure that Spill/Sort memory reservation uses between 40% and 60% of the heap of a map task.
Reduce Task Sanity Checks	**Value**	**Description**
Reduce task vcore request must fit within scheduler limits	GOOD	yarn.scheduler.minimum-allocation-vcores <= **mapreduce.reduce.cpu.vcores** <= yarn-scheduler.maximum-allocation-vcores
Reduce task memory request must fit within scheduler limits	GOOD	yarn.scheduler.minimum-allocation-mb <= **mapreduce.reduce.memory.mb** <= yarn.scheduler.maximum-allocation-mb
Container size must large enough for java heap and overhead	N/A	Java Heap should be between 75% and 90% of the container size: too low wastes resources, to high could lead to OOM

Set properties in Cloudera Manager

When you are satisfied with the cluster configuration estimates, use the values in the spreadsheet to set the corresponding properties in Cloudera Manager

Table 1: Cloudera Manager Property Correspondence

Step	YARN/MapReduce Property	Cloudera Manager Equivalent
4	yarn.nodemanager.resource.cpu-vcores	Container Virtual CPU Cores
4	yarn.nodemanager.resource.memory-mb	Container Memory
6	yarn.scheduler.minimum-allocation-vcores	Container Virtual CPU Cores Minimum
6	yarn.scheduler.maximum-allocation-vcores	Container Virtual CPU Cores Maximum
6	yarn.scheduler.increment-allocation-vcores	Container Virtual CPU Cores Increment
6	yarn.scheduler.minimum-allocation-mb	Container Memory Minimum
6	yarn.scheduler.maximum-allocation-mb	Container Memory Maximum
6	yarn.scheduler.increment-allocation-mb	Container Memory Increment
7	yarn.app.mapreduce.am.resource.cpu-vcores	ApplicationMaster Virtual CPU Cores
7	yarn.app.mapreduce.am.resource.mb	ApplicationMaster Memory
7	mapreduce.map.cpu.vcores	Map Task CPU Virtual Cores
7	mapreduce.map.memory.mb	Map Task Memory
7	mapreduce.reduce.cpu.vcores	Reduce Task CPU Virtual Cores
7	mapreduce.reduce.memory.mb	Reduce Task Memory
7	mapreduce.task.io.sort.mb	I/O Sort Memory

Configure memory settings

The memory configuration for YARN and MapReduce memory is important to get the best performance from your cluster.

Several different settings are involved. The table below shows the default settings, as well as the settings that Cloudera recommends, for each configuration option.

Table 2: YARN and MapReduce Memory Configuration

Cloudera Manager Property Name	Cloudera Runtime Property Name	Default Configuration	Cloudera Tuning Guidelines
Container Memory Minimum	yarn.scheduler.minimum-allocation-mb	1 GB	0
Container Memory Maximum	yarn.scheduler.maximum-allocation-mb	64 GB	amount of memory on largest host
Container Memory Increment	yarn.scheduler.increment-allocation-mb	512 MB	Use a fairly large value, such as 128 MB
Container Memory	yarn.nodemanager.resource.memory-mb	8 GB	8 GB
Map Task Memory	mapreduce.map.memory.mb	1 GB	1 GB
Reduce Task Memory	mapreduce.reduce.memory.mb	1 GB	1 GB
Map Task Java Opts Base	mapreduce.map.java.opts	-Djava.net.preferIPv4Stack=true	-Djava.net.preferIPv4Stack=true -Xmx768m
Reduce Task Java Opts Base	mapreduce.reduce.java.opts	-Djava.net.preferIPv4Stack=true	-Djava.net.preferIPv4Stack=true -Xmx768m
ApplicationMaster Memory	yarn.app.mapreduce.am.resource.mb	1 GB	1 GB

Cloudera Manager Property Name	Cloudera Runtime Property Name	Default Configuration	Cloudera Tuning Guidelines
ApplicationMaster Java Opts Base	yarn.app.mapreduce.am.command-opt	-Djava.net.preferIPv4Stack=true	-Djava.net.preferIPv4Stack=true -Xmx768m

YARN Configuration Properties

This table provides information about the parameters listed in the yarn-site.xml file.

Parameter	Value
hadoop.registry.zk.quorum	c2185-node3.coelab.test.com:2181
yarn.acl.enable	true
yarn.admin.acl	yarn
yarn.am.liveness-monitor.expiry-interval-ms	600000
yarn.application.classpath	$HADOOP_CLIENT_CONF_DIR,$HADOOP_COMMON_HOME/*,$HADOOP_COMMON_HOME/lib/*,$HADOOP_HDFS_HOME/*,$HADOOP_HDFS_HOME/lib/*,$HADOOP_YARN_HOME/*,$HADOOP_YARN_HOME/lib/*
yarn.authorization-provider	org.apache.ranger.authorization.yarn.authorizer.RangerYarnAuthorizer
yarn.cluster.scaling.recommendation.enable	false
yarn.log-aggregation-enable	true
yarn.log-aggregation-status.time-out.ms	600000
yarn.log-aggregation.IFile.remote-app-log-dir	/tmp/logs
yarn.log-aggregation.IFile.remote-app-log-dir-suffix	ifile
yarn.log-aggregation.TFile.remote-app-log-dir-suffix	
yarn.log-aggregation.file-controller.IFile.class	org.apache.hadoop.yarn.logaggregation.filecontroller.ifile.LogAggregationIndexedFileCor
yarn.log-aggregation.file-controller.TFile.class	org.apache.hadoop.yarn.logaggregation.filecontroller.tfile.LogAggregationTFileController
yarn.log-aggregation.file-formats	IFile,TFile
yarn.log-aggregation.retain-seconds	604800
yarn.nm.liveness-monitor.expiry-interval-ms	600000
yarn.node-labels.enabled	true
yarn.resourcemanager.address	c2185-node3.coelab.test.com:8032
yarn.resourcemanager.admin.address	c2185-node3.coelab.test.com:8033
yarn.resourcemanager.admin.client.thread-count	1
yarn.resourcemanager.am.max-attempts	2
yarn.resourcemanager.amliveliness-monitor.interval-ms	1000
yarn.resourcemanager.client.thread-count	50
yarn.resourcemanager.container.liveness-monitor.interval-ms	600000
yarn.resourcemanager.max-completed-applications	10000
yarn.resourcemanager.nm.liveness-monitor.interval-ms	1000
yarn.resourcemanager.nodes.exclude-path	/var/run/cloudera-scm-agent/process/1546333423-yarn-RESOURCEMANAGER/nodes_exclude.txt
yarn.resourcemanager.nodes.include-path	/var/run/cloudera-scm-agent/process/1546333423-yarn-RESOURCEMANAGER/nodes_allow.txt

Parameter	Value
yarn.resourcemanager.placement-constraints.handler	scheduler
yarn.resourcemanager.proxy-user-privileges.enabled	true
yarn.resourcemanager.recovery.enabled	true
yarn.resourcemanager.resource-tracker.address	c2185-node3.coelab.test.com:8031
yarn.resourcemanager.resource-tracker.client.thread-count	50
yarn.resourcemanager.scheduler.address	c2185-node3.coelab.test.com:8030
yarn.resourcemanager.scheduler.class	org.apache.hadoop.yarn.server.resourcemanager.scheduler.capacity.CapacityScheduler
yarn.resourcemanager.scheduler.client.thread-count	50
yarn.resourcemanager.scheduler.monitor.enable	true
yarn.resourcemanager.store.class	org.apache.hadoop.yarn.server.resourcemanager.recovery.ZKRMStateStore
yarn.resourcemanager.webapp.address	c2185-node3.coelab.test.com:8088
yarn.resourcemanager.webapp.cross-origin.enabled	true
yarn.resourcemanager.webapp.https.address	c2185-node3.coelab.test.com:8090
yarn.resourcemanager.work-preserving-recovery.enabled	true
yarn.resourcemanager.zk-address	c2185-node3.coelab.test.com:2181
yarn.resourcemanager.zk-timeout-ms	60000
yarn.scheduler.capacity.resource-calculator	org.apache.hadoop.yarn.util.resource.DominantResourceCalculator
yarn.scheduler.configuration.store.class	zk
yarn.scheduler.fair.allow-undeclared-pools	true
yarn.scheduler.fair.assignmultiple	true
yarn.scheduler.fair.continuous-scheduling-enabled	false
yarn.scheduler.fair.continuous-scheduling-sleep-ms	5
yarn.scheduler.fair.dynamicmaxassign	true
yarn.scheduler.fair.locality-delay-node-ms	2000
yarn.scheduler.fair.locality-delay-rack-ms	4000
yarn.scheduler.fair.maxassign	-1
yarn.scheduler.fair.preemption	false
yarn.scheduler.fair.preemption.cluster-utilization-threshold	0.8
yarn.scheduler.fair.sizebasedweight	false
yarn.scheduler.fair.user-as-default-queue	true
yarn.scheduler.increment-allocation-mb	512
yarn.scheduler.increment-allocation-vcores	1
yarn.scheduler.maximum-allocation-mb	2568
yarn.scheduler.maximum-allocation-vcores	2
yarn.scheduler.minimum-allocation-mb	1024
yarn.scheduler.minimum-allocation-vcores	1
yarn.service.classpath	$HADOOP_CLIENT_CONF_DIR
yarn.service.framework.path	/user/yarn/services/service-framework/7.1.1/service-dep.tar.gz
yarn.webapp.api-service.enable	true

Parameter	Value
yarn.webapp.filter-entity-list-by-user	true
yarn.webapp.ui2.enable	true

For information about the YARN configuration properties supported by Cloudera Manager, see *Cloudera Manager* documentation.

Use the YARN REST APIs to manage applications

You can use the YARN REST APIs to submit, monitor, and kill applications.

Important: In a non-secure cluster, you must append a request with ?user.name=<user>.

Example: Get application data

- Without ?user.name=<user>:

```
curl http://localhost:19888/jobhistory/job/job_1516861688424_0001
Access denied: User null does not have permission to view job job_
1516861688424_0001
```

- With ?user.name=<user>:

```
curl http://localhost:19888/jobhistory/job/job_1516861688424_0001?user.name=hrt_1
{"job":{"submitTime":1516863297896,"startTime":1516863310110,"finishTime":1516863330610,
"id":"job_1516861688424_0001","name":"Sleepjob","queue":"default","user":"hrt_1",
"state":"SUCCEEDED","mapsTotal":1,"mapsCompleted":1,"reducesTotal":1,"reducesCompleted":1,
"uberized":false,"diagnostics":"","avgMapTime":10387,"avgReduceTime":536,"avgShuffleTime":4727,
"avgMergeTime":27,"failedReduceAttempts":0,"killedReduceAttempts":0,"successfulReduceAttempts":1,
"failedMapAttempts":0,"killedMapAttempts":0,"successfulMapAttempts":1,"acls":[{"name":"mapreduce.j
ob.acl-
view-job","value":" "},{"name":"mapreduce.job.acl-modify-job","value":" "}]}}
```

Get an Application ID

You can use the New Application API to get an application ID, which can then be used to submit an application. For example:

```
curl -v -X POST 'http://localhost:8088/ws/v1/cluster/apps/new-application'
```

The response returns the application ID, and also includes the maximum resource capabilities available on the cluster. For example:

```
    {
    application-id: application_1409421698529_0012",
    "maximum-resource-capability":{"memory":"8192","vCores":"32"}
    }
```

Set Up an Application .json File

Before you submit an application, you must set up a .json file with the parameters required by the application. This is analogous to creating your own ApplicationMaster. The application .json file contains all of the fields you are required to submit in order to launch the application.

The following is an example of an application .json file:

```
{
   "application-id":"application_1404203615263_0001",
   "application-name":"test",
```

```
    "am-container-spec":
    {
       "local-resources":
       {
          "entry":
         [
            {
               "key":"AppMaster.jar",
               "value":
               {
                  "resource":"hdfs://hdfs-namenode:9000/user/testuser/Dis
tributedShell/demo-app/AppMaster.jar",
                  "type":"FILE",
                  "visibility":"APPLICATION",
                  "size": "43004",
                  "timestamp": "1405452071209"
               }
            }
          ]
       },
       "commands":
       {
          "command":"{{JAVA_HOME}}/bin/java -Xmx10m org.apache.hadoop.yar
n.applications.distributedshell.ApplicationMaster --container_memory 10 --co
ntainer_vcores 1 --num_containers 1 --priority 0 1><LOG_DIR>/AppMaster.stdou
t 2><LOG_DIR>/AppMaster.stderr"
       },
       "environment":
       {
          "entry":
          [
             {
                "key": "DISTRIBUTEDSHELLSCRIPTTIMESTAMP",
                "value": "1405459400754"
             },
             {
                "key": "CLASSPATH",
                "value": "{{CLASSPATH}}<CPS>./*<CPS>{{HADOOP_CONF_DIR}}<C
PS>{{HADOOP_COMMON_HOME}}/share/hadoop/common/*<CPS>{{HADOOP_COMMON_HOME}}/s
hare/hadoop/common/lib/*<CPS>{{HADOOP_HDFS_HOME}}/share/hadoop/hdfs/*<CPS>{{
HADOOP_HDFS_HOME}}/share/hadoop/hdfs/lib/*<CPS>{{HADOOP_YARN_HOME}}/share/ha
doop/yarn/*<CPS>{{HADOOP_YARN_HOME}}/share/hadoop/yarn/lib/*<CPS>./log4j.pro
perties"
             },
             {
                "key": "DISTRIBUTEDSHELLSCRIPTLEN",
                "value": "6"
             },
             {
                "key": "DISTRIBUTEDSHELLSCRIPTLOCATION",
                "value": "hdfs://hdfs-namenode:9000/user/testuser/demo-app/
shellCommands"
             }
          ]
       }
    },
    "unmanaged-AM":"false",
    "max-app-attempts":"2",
    "resource":
    {
       "memory":"1024",
       "vCores":"1"
    },
    "application-type":"YARN",
```

```
    "keep-containers-across-application-attempts":"false"
  }
```

Submit an Application

You can use the Submit Application API to submit applications. For example:

```
curl -v -X POST -d @example-submit-app.json -H "Content-type: application/js
on"'http://localhost:8088/ws/v1/cluster/apps'
```

After you submit an application the response includes the following field:

```
HTTP/1.1 202 Accepted
```

The response also includes the Location field, which you can use to get the status of the application (app ID). The following is an example of a returned Location code:

```
Location: http://localhost:8088/ws/v1/cluster/apps/application_1409421698529
_0012
```

Monitor an Application

You can use the Application State API to query the application state. To return only the state of a running application, use the following command format:

```
curl 'http://localhost:8088/ws/v1/cluster/apps/application_1409421698529_001
2/state'
```

You can also use the value of the Location field (returned in the application submission response) to check the application status. For example:

```
curl -v 'http://localhost:8088/ws/v1/cluster/apps/application_1409421698529_
0012'
```

You can use the following command format to check the logs:

```
yarn logs -appOwner 'dr.who' -applicationId application_1409421698529_0012 |
 less
```

Kill an Application

You can also use the Application State API to kill an application by using a PUT operation to set the application state to KILLED. For example:

```
curl -v -X PUT -H 'Accept: application/json' -H 'Content-Type: application/j
son' -d '{"state": "KILLED"}' 'http://localhost:8088/ws/v1/cluster/apps/appl
ication_1409421698529_0012/state'
```

Comparison of Fair Scheduler with Capacity Scheduler

This section provides information about choosing Capacity Scheduler, its benefits, and performance improvements along with features comparison between Fair Scheduler and Capacity Scheduler.

Why one scheduler?

Cloudera Data Platform (CDP) only supports the Capacity Scheduler in the YARN clusters.

Prior to the launch of CDP, Cloudera customers used one of the two schedulers (Fair Scheduler and Capacity Scheduler) depending on which product they were using (CDH or HDP respectively).

The choice to converge to one scheduler in CDP was a hard one but ultimately rooted in our intention to reduce complexity for our customers and at the same time help focus our future investments. Over the years, both the schedulers have evolved greatly, to the point that Fair Scheduler borrowed almost all of the features from Capacity Scheduler and vice-versa. Given this, we ultimately decided to put our weight behind Capacity Scheduler for all your YARN clusters.

Those clusters that currently use the Fair scheduler must migrate to the Capacity Scheduler when moving to CDP. Cloudera provides tools, documentation, and related help for such migrations.

Benefits of Using Capacity Scheduler

The following are some of the benefits when using Capacity Scheduler:

- Integration with Ranger
- Node partitioning/labeling
- Improvements to schedule on cloud-native environments, such as better bin-packing, autoscaling support, and so on.
- Scheduling throughput improvements
  - Global Scheduling Framework
  - Lookup of multiple nodes at one time

Fore more details about Scheduling throughput improvements, see Scheduler Performance Improvements.

- Affinity/anti-affinity: run application X only on those nodes which run application Y and the other way around. Do not run application X and application Y on the same node.

For information about the currently supported features, see Supported Features.

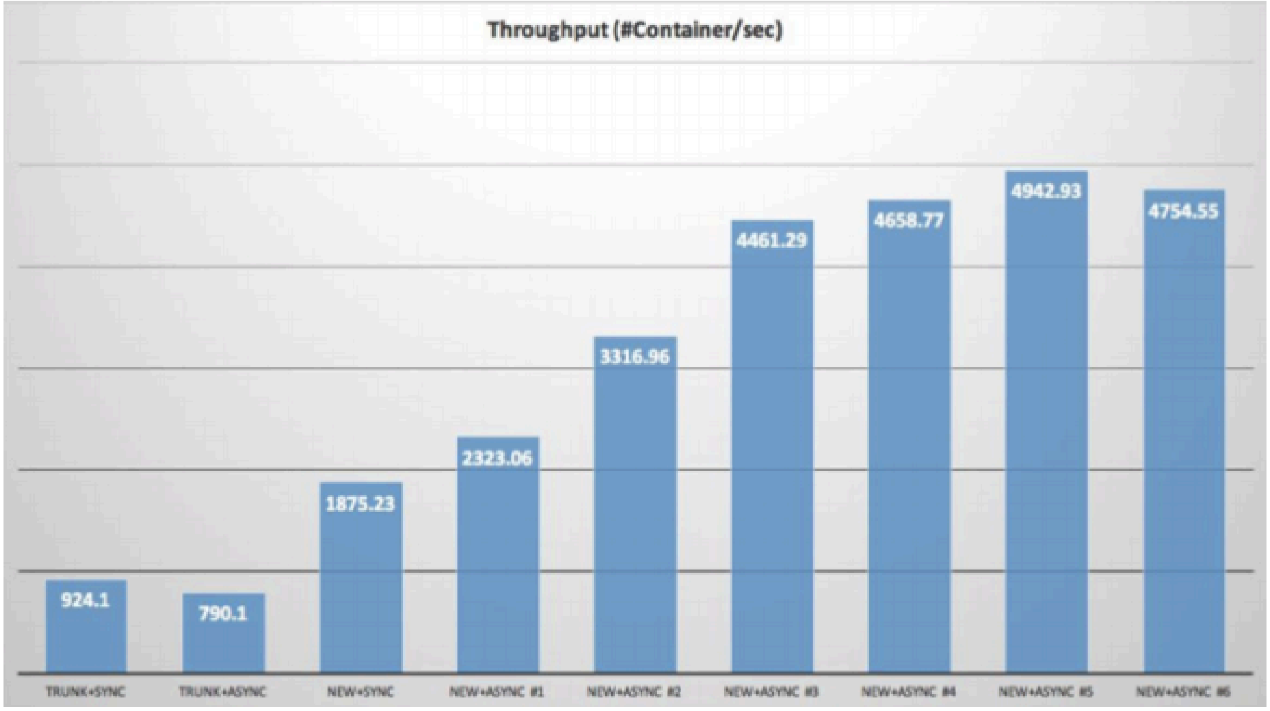
Scheduler performance improvements

Provides information about Global scheduling feature and its test results.

Improvements brought by Global Scheduling Improvements (YARN-5139)

Before the changes of global scheduling, the YARN scheduler was under a monolithic lock, which was underperforming. Global scheduling largely improved the internal locking structure and the thread-model of how the YARN scheduler works. The scheduler can now decouple placement decisions and change the internal data structure. This can also enable to lookup multiple nodes at a time, which is used by auto-scaling and bin-packing policies on cloud. For more information, see the design and implementation notes.

Based on the simulation, the test result of using Global Scheduling feature shows:



This is a simulated environment which has 20000 nodes and 47000 running applications. For more information about these tests, see the performance report.

Performance test from YARN community

Microsoft published Hydra: a federated resource manager for data-center scale analytics (Carlo, et al) report which highlights the scalability (Deployed YARN to more than 250k nodes, which includes five large federated cluster, each of them having 50k nodes) and scheduling performance (each cluster's scheduler can make more than 40k container allocation per second) by using Capacity Scheduler. This is the largest known YARN deployment in the world.

We also saw performance numbers from other companies in the community in line with what we have tested using simulators (thousands of container allocations per second for a cluster that has thousands of nodes).

Disclaimer: The performance number discussed above is related to the size of the cluster, workloads running on the cluster, queue structure, healthiness (such as node manager, disk, and network), container churns, and so on. This typically needs fine-tuning efforts for the scheduler and other cluster parameters to reach the ideal performance. This is NOT a guaranteed number which can be achieved just by using CDP.

Feature comparison

The features of both schedulers have become similar over time. The current feature list and differences between the two schedulers is listed in the tables.

Supported Features

Feature List		Capacity Scheduler	Fair Scheduler	Comments
Queues	Hierarchical Queues	yes	yes	
	Elastic Queue Capacity for better resource sharing	yes	yes	
	Percentage Based Resource Configuration in Queues	yes	yes	Percentages and absolute resources settings cannot be used simultaneous.

	Auto Queue Creation	yes	yes	
	User Mapping (user/group to queue mapping)	yes	yes	
	CLI/REST API support to manage queues	yes	yes	
	Move applications between queues	yes	yes	
	Dynamic Queue creation/ deletion/modification	yes	yes	
	Reservation support in queues	yes	yes	
Authorization	Authorization control (ACLs in Queues for submit/manage/admin)	yes	yes	
	Third party ACL control (Ranger)	yes	yes	
Application Placement	Node Labels support	yes	no	
	Hive placement integration	yes	yes	
	Node Attributes support	yes	no	
	Placement constraints support	yes	no	Supported constraints are limited in the current implementation.
	Node Locality	yes	yes	
	Locality Delay control	yes	yes	
	User limit quota management	yes	yes	
	AM resource quota management	yes	yes	
	Queue Priority	yes	no	Indirectly managed through queue weights.
	Maximum and Minimum allocation limit per container unit	yes	yes	
Scheduling	Asynchronous scheduling support	yes	yes	Implementation differs between the schedulers and should not be treated as equivalent.
	Multiple resource types support (CPU, Memory, GPU, and so on)	yes	yes	
	Queue Ordering Policies (Fair, FIFO, and so on)	yes	yes	
	Multiple container assignments per heartbeat	yes	yes	
Preemption	Inter Queue preemption support	yes	yes	
	Intra Queue preemption support	yes	yes	
	Reservation based preemption	yes	yes	

	Queue Priority based preemption	yes	no	Queue weights are taken into account when preempting decisions are made.
Application Support	First class Concept of application	yes	yes	
	Application priority	yes	yes	
	Application timeout	yes	yes	
	Moving Application across queues	yes	yes	
	High Availability stateful application recovery	yes	yes	

Roadmap Features

Feature List		Capacity Scheduler	Fair Scheduler	Comments
Queues	Absolute Resource Configuration in Queues	yes	yes	Percentages and absolute resources settings cannot be usedsimultaneously.
Application Placement	Maximum number of applications	no	yes	Indirectly managed through AM resource quotas.
Scheduling	Application Size Based Fairness	no	yes	

Migration from Fair Scheduler to Capacity Scheduler

Starting from the CDP CDP Private Cloud Base 7.1 release, Cloudera provides the `fs2cs` conversion utility, which is a CLI application and is a part of the YARN CLI command. This utility helps to migrate from Fair Scheduler to Capacity Scheduler.

For information about using the `fs2cs` conversion utility, the scheduler conversion process, and manual configurations, see Migrating Fair Scheduler to Capacity Scheduler.