

DUCC Installation and Verification

Excerpt From Complete DUCC Documentation

Written and maintained by the Apache
UIMATM Development Community

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Publication date: August 2015

Overview

DUCC is a multi-user, multi-system distributed application. The instructions below follow a staged installation/verification methodology, roughly as follows:

- Single system installation.
- Add new machines to DUCC control.
- Enable processes to run with the credentials of multiple submitting user. This step requires root authority on one or more machines.
- Enable CGroup containers. This step requires root authority on every DUCC machine.

DUCC is distributed as a compressed tar file. The instructions below assume installation from one of this distribution media. If building from source, the build creates this file in your svn trunk/target directory. The distribution file is in the form

```
uima-ducc-[version]-bin.tar.gz
```

where [version] is the DUCC version; for example, *uima-ducc-VERSION-bin.tar.gz* (where VERSION is the current DUCC version). This document will refer to the distribution file as the “<distribution.file>”.

Software Prerequisites

Single system installation:

- Reasonably current Linux. DUCC has been tested on SLES 11.x and RHEL 6.x
Note: On some systems the default *user limits* for max user processes (ulimit -u) and nfiles (ulimit -n) are defined too low for DUCC. The shell login profile for user *ducc* should set the soft limit for max user processes to be the same as the hard limit (ulimit -u 'ulimit -Hu'), and the nfiles limit raised above 1024 to at least twice the number of user processes running on the cluster.
- Python 2.x, where 'x' is 4 or greater. DUCC has not been tested on Python 3.x.
- Java 7. DUCC has been tested and run using IBM and Oracle JDK 1.7.
- Passwordless ssh for user running DUCC

Additional requirements for multiple system installation:

- All systems must have a shared filesystem (such as NFS or GPFS) and common user space. The \$DUCC_HOME directory must be located on a shared filesystem.

Additional requirements for running multiple user processes with their own credentials.

- A userid *ducc*, and group *ducc*. User *ducc* must be the only member of group *ducc*.
- DUCC run with user *ducc* credentials.
- Root access is required to setuid-root the DUCC process launcher.

Additional requirements for CGroup containers:

- A userid *ducc*, and group *ducc*. User *ducc* must be the only member of group *ducc*.
- DUCC run with user *ducc* credentials.
- libcgroup1-0.37+ on SLES and libcgroup-0.37+ on RHEL, along with a custom /etc/cgconfig.conf

In order to build DUCC from source the following software is also required:

- A Subversion client, from <http://subversion.apache.org/packages.html>. The svn url is <https://svn.apache.org/repos/asf/uima/sandbox/uima-ducc/trunk>.

- Apache Maven, from <http://maven.apache.org/index.html>

The DUCC webserver server optionally supports direct “jconsole” attach to DUCC job processes. To install this, the following is required:

- Apache Ant, any reasonably current version.

To (optionally) build the documentation, the following is also required:

- Latex, including the *pdflatex* and *htlatex* packages. A good place to start if you need to install it is <https://www.tug.org/texlive/>.

More detailed one-time setup instructions for source-level builds via subversion can be found here: <http://uima.apache.org/one-time-setup.html#svn-setup>

Building from Source

To build from source, ensure you have Subversion and Maven installed. Extract the source from the SVN repository named above.

Then from your extract directory into the root directory (usually `current-directory/trunk`), and run the command

```
mvn install
```

or

```
mvn install -Pbuild-duccdocs
```

if you have LaTeX installed and wish to do the optional build of documentation.

If this is your first Maven build it may take quite a while as Maven downloads all the open-source pre-requisites. (The pre-requisites are stored in the Maven repository, usually your `$HOME/.m2`).

When build is complete, a tarball is placed in your `current-directory/trunk/target` directory.

Documentation

After installation the DUCC documentation is found (in both PDF and HTML format) in the directory `ducc_runtime/docs`. As well, the DUCC webserver contains a link to the full documentation on each major page. The API is documented only via JavaDoc, distributed in the webserver’s root directory `$DUCC_HOME/webserver/root/doc/api`.

If building from source, Maven places the documentation in

- `trunk/uima-ducc-duccdocs/target/site` (main documentation), and
- `trunk/target/site/apidocs` (API Javadoc)

Single System Installation and Verification

Although any user ID can be used to run DUCC, it is recommended to create user “ducc” to later enable use of cgroups as well as running processes with the credentials of the submitting user.

If multiple nodes are going to be added later, it is recommended to install the ducc runtime tree on a shared filesystem so that it can be mounted on the additional nodes.

Verification submits a very simple UIMA pipeline for execution under DUCC. Once this is shown to be working, one may proceed installing additional features.

Minimal Hardware Requirements for Single System Installation

- One Intel-based or IBM Power-based system. (More systems may be added later.)
- 8GB of memory. 16GB or more is preferable for developing and testing applications beyond the non-trivial.
- 1GB disk space to hold the DUCC runtime, system logs, and job logs. More is usually needed for larger installations.

Please note: DUCC is intended for scaling out memory-intensive UIMA applications over computing clusters consisting of multiple nodes with large (16GB-256GB or more) memory. The minimal requirements are for initial test and evaluation purposes, but will not be sufficient to run actual workloads.

Single System Installation

1. Expand the distribution file with the appropriate umask:

```
(umask 022 && tar -zxf <distribution.file>)
```

This creates a directory with a name of the form “apache-uima-ducc-[version]”.

This directory contains the full DUCC runtime which you may use “in place” but it is highly recommended that you move it into a standard location on a shared filesystem; for example, under ducc’s HOME directory:

```
mv apache-uima-ducc-[version] /home/ducc/ducc_runtime
```

We refer to this directory, regardless of its location, as \$DUCC_HOME. For simplicity, some of the examples in this document assume it has been moved to /home/ducc/ducc_runtime.

2. Change directories into the admin sub-directory of \$DUCC_HOME:

```
cd $DUCC_HOME/admin
```

3. Run the post-installation script:

```
./ducc_post_install
```

If this script fails, correct any problems it identifies and run it again.

Note that *ducc_post_install* initializes various default parameters which may be changed later by the system administrator. Therefore it usually should be run only during this first installation step.

4. If you wish to install jconsole support from the webserver, make sure Apache Ant is installed, and run

```
./sign_jconsole_jar
```

This step may be run at any time if you wish to defer it.

That’s it, DUCC is installed and ready to run. (If errors were displayed during *ducc_post_install* they must be corrected before continuing.)

The post-installation script performs these tasks:

1. Verifies that the correct level of Java and Python are installed and available.
2. Creates a default nodelist, \$DUCC_HOME/resources/ducc.nodes, containing the name of the node you are installing on.
3. Defines the “ducc head” node to be to node you are installing from.
4. Sets up the default https keystore for the webserver.
5. Installs the DUCC documentation “ducc book” into the DUCC webserver root.
6. Builds and installs the C program, “ducc.ling”, into the default location.

7. Ensures that the (supplied) ActiveMQ broker is runnable.

Initial System Verification

Here we verify the system configuration, start DUCC, run a test Job, and then shutdown DUCC.

To run the verification, issue these commands.

1. `cd $DUCC_HOME/admin`
2. `./check_ducc`

Examine the output of `check_ducc`. If any errors are shown, correct the errors and rerun `check_ducc` until there are no errors.

3. Finally, start `ducc`: `./start_ducc`

`Start_ducc` will first perform a number of consistency checks. It then starts the ActiveMQ broker, the DUCC control processes, and a single DUCC agent on the local node.

You will see some startup messages similar to the following:

```
ENV: Java is configured as: /share/jdk1.7/bin/java
ENV: java full version "1.7.0_40-b43"
ENV: Threading enabled: True
MEM: memory is 15 gB
ENV: system is Linux
allnodes /home/ducc/ducc_runtime/resources/ducc.nodes
Class definition file is ducc.classes
OK: Class and node definitions validated.
OK: Class configuration checked
Starting broker on duchead.biz.org
Waiting for broker ..... 0
Waiting for broker ..... 1
ActiveMQ broker is found on configured host and port: duchead.biz.org:61616
Starting 1 agents
***** Starting agents from file /home/ducc/ducc_runtime/resources/ducc.nodes
Starting warm
Waiting for Completion
duchead.biz.org Starting rm
    PID 14198
duchead.biz.org Starting pm
    PID 14223
duchead.biz.org Starting sm
    PID 14248
duchead.biz.org Starting or
    PID 14275
duchead.biz.org Starting ws
    PID 14300
duchead.biz.org
    ducc_ling OK
    DUCC Agent started PID 14325
All threads returned
```

Now open a browser and go to the DUCC webserver's url, `http://<hostname>:42133` where `<hostname>` is the name of the host where DUCC is started. Navigate to the Reservations page via the links in the upper-left corner. You should see the DUCC JobDriver reservation in state `WaitingForResources`. In a few minutes this should change to `Assigned`. Now jobs can be submitted.

To submit a job,

1. `$DUCC_HOME/bin/ducc_submit -specification $DUCC_HOME/examples/simple/1.job`

Open the browser in the DUCC jobs page. You should see the job progress through a series of transitions: Waiting For Driver, Waiting For Services, Waiting For Resources, Initializing, and finally, Running. You'll see the number of work items submitted (15) and the number of work items completed grow from 0 to 15. Finally, the job will move into Completing and then Completed..

Since this example does not specify a log directory DUCC will create a log directory in your HOME directory under `$HOME/ducc/logs/job-id`

In this directory, you will find a log for the sample job's JobDriver (JD), JobProcess (JP), and a number of other files relating to the job.

This is a good time to explore the DUCC web pages. Notice that the job id is a link to a set of pages with details about the execution of the job.

Notice also, in the upper-right corner is a link to the full DUCC documentation, the "DuccBook".

Finally, stop DUCC:

1. `cd $DUCC_HOME/admin`
2. `./stop-ducc -a`

Add additional nodes to the DUCC cluster

Additional nodes must meet all *prerequisites* (listed above).

`$DUCC_HOME` must be on a shared filesystem and mounted at the same location on all DUCC nodes.

If user's home directories are on local filesystems the location for user logfiles should be specified to be on a shared filesystem.

Additional nodes are normally added to a worker node group. Note that the DUCC head node does not have to be a worker node. In addition, the webserver node can be separate from the DUCC head node (see webserver configuration options in `ducc.properties`).

For worker nodes DUCC needs to know what node group each machine belongs to, and what nodes need an Agent process to be started on.

The configuration shipped with DUCC have all nodes in the same "default" node pool. Worker nodes are listed in the file

`$DUCC_HOME/resources/ducc.nodes`.

During initial installation, this file was initialized with the node DUCC is installed on. Additional nodes may be added to the file using a text editor to increase the size of the DUCC cluster.

Ducc_ling Configuration - Running with credentials of submitting user

DUCC launches user processes through `ducc_ling`, a small native C application. By default the resultant process runs with the credentials of the user ID of the DUCC application. It is possible for multiple users to submit work to DUCC in this configuration, but it requires that the user ID running DUCC has write access to all directories to which the user process outputs data. By configuring the `ducc` user ID and `ducc_ling` correctly, work submitted by all users will run with their own credentials.

Before proceeding with this step, please note:

- The sequence operations consisting of *chown* and *chmod* MUST be performed in the exact order given below. If the *chmod* operation is performed before the *chown* operation, Linux will regress the permissions granted by *chmod* and *ducc.ling* will be incorrectly installed.

ducc.ling is designed to be a *setuid-root* program whose function is to run user processes with the identity of the submitting user. This must be installed correctly; incorrect installation can prevent jobs from running as their submitters, and in the worse case, can introduce security problems into the system.

ducc.ling can either be installed on a local disk on every system in the DUCC cluster, or on a shared-filesystem that does not suppress *setuid-root* permissions on client nodes. The path to *ducc.ling* must be the same on each DUCC node. The default path configuration is `$DUCC_HOME/admin/${os.arch}/` in order to handle clusters with mixed OS platforms. `${os.arch}` is the architecture specific value of the Java system property with that name; examples are `amd64` and `ppc64`.

The steps are: build *ducc.ling* for each node architecture to be added to the cluster, copy *ducc.ling* to the desired location, and then configure *ducc.ling* to give user *ducc* the ability to spawn a process as a different user.

In the example below *ducc.ling* is left under `$DUCC_HOME`, where it is built.

As user *ducc*, build *ducc.ling* for necessary architectures (this is done automatically for the DUCC head machine by the *ducc_post_install* script). For each unique OS platform:

1. `cd $DUCC_HOME/admin`
2. `./build_duccling`

Then, as user *root* on the shared filesystem, `cd $DUCC_HOME/admin`, and for each unique OS architecture:

1. `chown ducc.ducc ${os.arch}`
(set directory ownership to be user *ducc*, group *ducc*)
2. `chmod 700 ${os.arch}`
(only user *ducc* can read contents of directory)
3. `chown root.ducc ${os.arch}/ducc.ling`
(make *root* owner of *ducc.ling*, and let users in group *ducc* access it)
4. `chmod 4750 ${os.arch}/ducc.ling`
(*ducc.ling* runs as user *root* when started by users in group *ducc*)

If these steps are correctly performed, ONLY user *ducc* may use the *ducc.ling* program in a privileged way. *ducc.ling* contains checks to prevent even user *root* from using it for privileged operations.

If a different location is chosen for *ducc.ling* the new path needs to be specified for `ducc.agent.launcher.ducc_spawn_path` in `$DUCC_HOME/resources/site.ducc.properties`. See more info at see *properties merging* in the *duccbook*.

CGroups Installation and Configuration

Note: A key feature of DUCC is to run user processes in CGroups in order to guarantee each process always has the amount of RAM requested. RAM allocated to the managed process (and any child processes) that exceed requested DUCC memory size will be forced into swap space. Without CGroups a process that exceeds its requested memory size by N% is killed (default N=5 in `ducc.properties`), and memory use by child processes is ignored.

DUCC's CGroup configuration also allocates CPU resources to managed processes based on relative memory size. A process with 50% of a machine's RAM will be guaranteed at least 50% of the machine's CPU resources as well.

The steps in this task must be done as user *root* and user *ducc*.

To install and configure CGroups for DUCC:

1. Install the appropriate `libcgroup` package at level 0.37 or above (see *Installation Prerequisites*).

2. Configure `/etc/cgconfig.conf` as follows:

```
# Mount cgroups
mount {
    memory = /cgroup;
    cpu = /cgroup;
}
# Define cgroup ducc and setup permissions
group ducc {
    perm {
        task {
            uid = ducc;
        }
        admin {
            uid = ducc;
        }
    }
    memory {}
    cpu{}
}
```

3. Start the `cgconfig` service:

```
service cgconfig start
```

4. Verify `cgconfig` service is running by the existence of directory:

```
/cgroups/ducc
```

5. Configure the `cgconfig` service to start on reboot:

```
chkconfig cgconfig on
```

Note: if CGroups is not installed on a machine the DUCC Agent will detect this and not attempt to use the feature. CGroups can also be disabled for all machines (see `ducc.agent.launcher.cgroups.enable` in `ducc.properties`, described in the Ducebook.) or it can be disabled for individual machines (see `ducc.agent.exclusion.file` in `ducc.properties`, described in the Ducebook.)

Full DUCC Verification

This is identical to initial verification, with the one difference that the job “1.job” should be submitted as any user other than `ducc`. Watch the webserver and check that the job executes under the correct identity. Once this completes, DUCC is installed and verified.

Enable DUCC webserver login

This step is optional. As shipped, the webserver is disabled for logins. This can be seen by hovering over the Login text located in the upper right of most webserver pages:

```
System is configured to disallow logins
```

To enable logins, a Java-based authenticator must be plugged-in and the login feature must be enabled in the `ducc.properties` file by the DUCC administrator. Also, `ducc.ling` should be properly deployed (see `Ducc.ling Installation` section above).

A beta version of a Linux-based authentication plug-in is shipped with DUCC. It can be found in the source tree:

```
org.apache.uima.ducc.ws.authentication.LinuxAuthenticationManager
```

The Linux-based authentication plug-in will attempt to validate webserver login requests by appealing to the host OS. The user who wishes to login provides a userid and password to the webserver via https, which in-turn are handed-off to the OS for a success/failure reply.

To have the webserver employ the beta Linux-based authentication plug-in, the DUCC administrator should perform the following as user ducc:

1. `edit ducc.properties`
2. `locate: ducc.ws.login.enabled = false`
3. `modify: ducc.ws.login.enabled = true`
4. `save`

Note: The beta Linux-based authentication plug-in has limited testing. In particular, it was tested using:

Red Hat Enterprise Linux Workstation release 6.4 (Santiago)

Alternatively, you can provide your own authentication plug-in. To do so:

1. author a Java class that implements
`org.apache.uima.ducc.common.authentication.IAuthenticationManager`
2. create a jar file comprising your authentication class
3. put the jar file in a location accessible by the DUCC webserver, such as
`$DUCC_HOME/lib/authentication`
4. put any authentication dependency jar files there as well
5. `edit ducc.properties`
6. add the following:
`ducc.local.jars = authentication/*`
`ducc.authentication.implementer=<your.authenticator.class.Name>`
7. `locate: ducc.ws.login.enabled = false`
8. `modify: ducc.ws.login.enabled = true`
9. `save`