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# Operations Guide for Linux

all

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September 23, 2020



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## 1 Content

This document provides an operations guide for Linux based OS. The guide can be followed for installations, where the software have been deployed in a Docker based setup, as described in the installation guides. As there are small differences in the syntax of commands on different Linux distributions, the administrator may have to adjust commands accordingly for the specific Linux distribution.

You should read the Deployment and Installation documentation beforehand, in order to understand the components and their roles. Administrative knowledge of Linux and Docker administration is assumed.

## 2 Health Check of a System

Login to the backend server

```
1 ssh user@<server>
2 sudo su
3 cd deploy
```

### 2.1 Check Docker Host

The administrator must check and monitor the Docker Host performance and resources. These commands are available under all flavors of Linux and can be useful to monitor and find the actual causes of performance problem.

### 2.2 Memory and CPU

Linux `vmstat` command is used to display statistics of virtual memory, kernel threads, disks, system processes, I/O blocks, interrupts, CPU activity and much more. By default `vmstat` command is not available under Linux systems you need to install a package called `sysstat` that includes the `vmstat` program. Example `vmstat` usage:

```
1 # vmstat
2 procs -----memory----- -----swap----- -----io----- -system--
      -----cpu-----
3   r   b   swpd   free   buff   cache   si   so   bi   bo   in   cs us sy
      id wa st
4   3   0     0 529780   2088 393428     0     0     0     1     3   23   0   0
      100   0   0
```

Also the `free` command could be used to look into the memory usage and availability on the Docker Host. The `free` command provides information about unused and used memory and swap space

```
1 # free
2             total        used        free      shared  buff/cache
3   Mem:       1014992       91936      418376       63876      504680
      685536
4   Swap:          0          0          0
```

Consult the man pages for options and usage of `vmstat`.

## 2.3 Disk Usage

Disk usage and free space, can be observed using the `df` command:

```
1 # df -h
2 Filesystem      Size  Used Avail Use% Mounted on
3 /dev/vda1        25G  3.8G  22G  16% /
4 devtmpfs        473M     0  473M   0% /dev
5 tmpfs           496M     0  496M   0% /dev/shm
6 tmpfs           496M   63M  434M  13% /run
7 tmpfs           496M     0  496M   0% /sys/fs/cgroup
8 tmpfs           100M     0  100M   0% /run/user/0
```

Consult the man pages for options and usage of `df`.

## 2.4 Running Processes

`top` and `htop` commands are performance monitoring programs used by many system administrators to monitor Linux performance. The commands are used to display all the running and active real-time processes in ordered list and updates it regularly. It displays CPU usage, Memory usage, Swap Memory, Cache Size, Buffer Size, Process PID, User, Commands and much more. It also shows high memory and CPU utilization of a running process. The `top` command is much useful for system administrator to monitor and take correct action when required. (`htop` is a third party tool and isn't included in Linux systems, you need to install it using the package manager)

```
1 # top
2 top - 11:23:31 up 21 days, 21:03,  1 user,  load average: 0.13, 0.08,
   0.06
3 Tasks:  89 total,   2 running,  87 sleeping,   0 stopped,   0 zombie
4 %Cpu(s):  1.0 us,  0.7 sy,  0.0 ni, 98.3 id,  0.0 wa,  0.0 hi,  0.0 si,
   0.0 st
5 KiB Mem : 1014992 total,   421240 free,    93980 used,   499772 buff/
   cache
6 KiB Swap:        0 total,        0 free,        0 used.  684172 avail
   Mem
7
8      PID USER      PR  NI      VIRT      RES      SHR S %CPU %MEM      TIME+
   COMMAND
9  6472 root      20   0    158748    5280    3976 S  0.7  0.5  0:00.02 sshd
10 6471 root      20   0    161896    2216   1560 R  0.3  0.2  0:00.04 top
11 6473 sshd      20   0    117204    2828   1712 S  0.3  0.3  0:00.01 sshd
```

12	1	root	20	0	46092	6532	4128	S	0.0	0.6	0:37.97
		systemd									
13	2	root	20	0	0	0	0	S	0.0	0.0	0:00.16
		kthreadd									
14	3	root	20	0	0	0	0	S	0.0	0.0	0:27.02
		ksoftirqd/0									
15	5	root	0	-20	0	0	0	S	0.0	0.0	0:00.00
		kworker/0:0H									
16	7	root	rt	0	0	0	0	S	0.0	0.0	0:00.00
		migration/0									
17	...										

## 2.5 Open Files

`lsof` command is used to display a list of all the open files and the processes. The open files included are disk files, network sockets, pipes, devices and processes. One of the main reason for using this command is when a disk cannot be unmounted and displays the error that files are being used or opened. With this command you can easily identify which files are in use. Another use is if the Docker Host is running out af filehandles.

To display all open files:

1	# lsof	2	COMMAND	PID	TID	USER	FD	TYPE	DEVICE	SIZE/
			OFF	OFF	NODE	NAME				
3	systemd		1		root	cwd		DIR		253,1
	224		64	/						
4	systemd		1		root	rtd		DIR		253,1
	224		64	/						
5	systemd		1		root	txt		REG		253,1
	1620384		299920		/usr/lib/systemd/systemd					
6	systemd		1		root	mem		REG		253,1
	20112		109252		/usr/lib64/libuuid.so.1.3.0					
7	systemd		1		root	mem		REG		253,1
	265624		109256		/usr/lib64/libblkid.so.1.1.0					
8	systemd		1		root	mem		REG		253,1
	90248		332379		/usr/lib64/libz.so.1.2.7					
9	systemd		1		root	mem		REG		253,1
	157424		109251		/usr/lib64/liblzma.so.5.2.2					
10	systemd		1		root	mem		REG		253,1
	23968		109278		/usr/lib64/libcap-ng.so.0.0.0					

```

11  systemd      1      root  mem      REG      253,1
     19896      109037 /usr/lib64/libattr.so.1.1.0
12  ...

```

Or to find top 10 processes using file handles:

```

1 # lsof | awk '{print $1}' | sort | uniq -c | sort -r | head -10
2      372 tuned
3      234 gssproxy
4      159 polkitd
5      146 sshd
6      146 gmain
7      130 master
8      106 JS
9      88 dbus-daem
10     72 systemd
11     68 auditd

```

## 2.6 Check Containers

Ensure that the backend services are running on the server as expected

```

1 # docker-compose ps
2      Name          Command          State
3      Ports
4
5      deploy_cuesta_1  /bin/sh -c /bin/sh -c "if ...  Up
6          0.0.0.0:443->443/tcp, 0.0.0.0:80->80/tcp
7      deploy_kwanza_1   kwanza serve      Up
8          0.0.0.0:6060->6060/tcp, 0.0.0.0:8000->8000/tcp, 0.0.0.0:8001->8001/
9          tcp
10     deploy_postgres_1  docker-entrypoint.sh postgres  Up
11          0.0.0.0:5444->5432/tcp

```

It is important that all three containers are in `Up` state. If one is not running, then it is a problem, as in this example, where the Postgres database container have stopped for some reason.

```

1 # docker-compose ps
2      Name          Command          State
3      Ports
4
5      deploy_cuesta_1  /bin/sh -c /bin/sh -c "if ...  Up
6          0.0.0.0:443->443/tcp, 0.0.0.0:80->80/tcp
7      deploy_kwanza_1   kwanza serve      Up
8          0.0.0.0:6060->6060/tcp, 0.0.0.0:8000->8000/tcp, 0.0.0.0:8001->8001/
9          tcp
10     deploy_postgres_1  docker-entrypoint.sh postgres  Up
11          0.0.0.0:5444->5432/tcp

```

```

3 -----
4 deploy_cuesta_1      /bin/sh -c /bin/sh -c "if ...    Up
  0.0.0.0:443->443/tcp, 0.0.0.0:80->80/tcp
5 deploy_kwanza_1      kwanza serve                  Up
  0.0.0.0:6060->6060/tcp, 0.0.0.0:8000->8000/tcp, 0.0.0.0:8001->8001/
  tcp
6 deploy_postgres_1    docker-entrypoint.sh postgres   Exit 137

```

If a container hosting a service have stopped, try to start it again to resolve the issue. Here we start the stopped Postgres database container.

```

1 # docker-compose up -d postgres
2 Starting deploy_postgres_1 ... done
3 # docker-compose ps
4          Name                  Command           State
5          Ports
6 deploy_cuesta_1      /bin/sh -c /bin/sh -c "if ...    Up
  0.0.0.0:443->443/tcp, 0.0.0.0:80->80/tcp
7 deploy_kwanza_1      kwanza serve                  Up
  0.0.0.0:6060->6060/tcp, 0.0.0.0:8000->8000/tcp, 0.0.0.0:8001->8001/
  tcp
8 deploy_postgres_1    docker-entrypoint.sh postgres   Up
  0.0.0.0:5444->5432/tcp

```

If the container is unable to start, the issue must be located and resolved in order to restore correct operations.

### 3 Operational Monitoring

In order to realise a reliable operation of the backend services, and thus of the complete system, monitoring is the first step towards this goal. Docker containers, are normally brought up and down on demand. They are ephemeral as they are lightweight and can be started up with little system overhead so they could be discarded when not actively in use.

Dockerization ensures the applications to be designed to work as distributed systems with each functional element is run in one more containers. That enabled a container based system to be scaled easily and the available compute resources could be allocated much more efficiently.

The benefits of monitoring are mainly:

- Monitoring helps to identify issues proactively that would help to avoid system outages.
- The monitoring time-series data provide insights to fine-tune applications for better performance and robustness.
- Changes could be rolled out safely as issues will be caught early on and be resolved quickly.
- Environmental changes and the impact these gets monitored indirectly.
- Availability of application services can be determined immediately.

### **3.1 Levels of Monitoring**

In order to monitor a container based application environment systematically, the monitoring should be implemented at various levels of the infrastructure and application.

### **3.2 Monitor Docker Host**

Docker containers are run on bare-metal or virtual machines. Monitoring of these machines for their availability and performance is important. This falls into the traditional infrastructure monitoring.

Typically, CPU, memory and storage usages are tracked and alerted based on the thresholds setup for those metrics. Implementing those are relatively easy as any monitoring tool would support it as part of core features.

### **3.3 Monitoring Containers**

The Docker containers are run on a set of hosts and a specific Docker instance could be running on any one of those hosts. You should monitor the running container instances. Tracking information on the up and running containers would be handy in monitoring the complete system availability and performance.

As with bare-metal and virtual machines, CPU, memory and storage metrics can be monitored for Docker containers as well. Container specific metrics related to CPU throttling, a situation when CPU cycles are allocated based on priorities set when there would be competition for available CPU, can also be tracked.

Tracking of these system performance metrics would help to determine whether resources on bare-metal and virtual machines, the container hosting infra, need to be upgraded. It would also provide insights to finetune the resources allocated to a Docker image so its future container instances will be started up with adequate runtime resources.

The native Docker command `docker stats` returns some of these metrics, but a surveillance and metric collection system is needed to capture these statistics system wide, for getting notified on potential issues and resolving those proactively.

### 3.4 Monitoring Application Endpoints

A container-based environment would be running a large, highly distributed application with each service running on one or more containers. The application checks could be done both at the container level and system-wide level. REST API endpoints on both Kwanza and Cuesta are available to perform such checks that could easily be plugged into any modern monitoring system to check the availability of related services.

## 4 Issue hunting on Postgres Database

In order to resolve issues on the Postgres Database container, the administrator may follow these steps. (For resolving issues in Postgres itself, follow best-practice for Postgres operations and maintenance.)

First try to start Postgres Database container in attached mode. This will give direct feedback on the process in the console. A normal startup will look similar to this (variations may occur based on the specific version)

```
1 # docker-compose up postgres
2 Starting deploy_postgres_1 ... done
3 Attaching to deploy_postgres_1
4 postgres_1 | 2019-09-10 12:49:52.785 UTC [1] LOG:  listening on IPv4
      address "0.0.0.0", port 5432
5 postgres_1 | 2019-09-10 12:49:52.786 UTC [1] LOG:  listening on IPv6
      address ":::", port 5432
6 postgres_1 | 2019-09-10 12:49:52.788 UTC [1] LOG:  listening on Unix
      socket "/var/run/postgresql/.s.PGSQL.5432"
7 postgres_1 | 2019-09-10 12:49:52.800 UTC [20] LOG:  database system
      was interrupted; last known up at 2019-09-10 12:43:24 UTC
8 postgres_1 | 2019-09-10 12:49:52.816 UTC [20] LOG:  database system
      was not properly shut down; automatic recovery in progress
9 postgres_1 | 2019-09-10 12:49:52.819 UTC [20] LOG:  redo starts at
      0/17FE768
10 postgres_1 | 2019-09-10 12:49:52.819 UTC [20] LOG:  invalid record
      length at 0/17FE7A0: wanted 24, got 0
11 postgres_1 | 2019-09-10 12:49:52.819 UTC [20] LOG:  redo done at 0/17
      FE768
```

```
12 postgres_1 | 2019-09-10 12:49:52.828 UTC [1] LOG:  database system is
      ready to accept connections
```

Look for hints as to why Postgres Database container will not start as expected. This may include issues such as disk full, low memory, to many open files, corrupt file system, etc. Follow best-pratice for Linux operation and maintenance if you encounter one of these.

Once the issue have been resolved, try to start the container again in attached mode. If startup succeeds, then stop the container and start it again in detached mode `-d` on the `docker-compose up` command.

## 5 Issue hunting on Kwanza

In order to resolve issues on the Kwanza container, the administrator may follo these steps.

First try to start Kwanza container in attached mode. This will give direct feedback on the process in the console. A normal startup will look similar to this (variations may occure based on the specific version)

```
1 # docker-compose up kwanza
2 deploy_postgres_1 is up-to-date
3 Starting deploy_kwanza_1 ... done
4 Attaching to deploy_kwanza_1
5 kwanza_1    | Either cert or key already exists, aborted cert- and key-
      generation
6 kwanza_1    | ##### INTERACTIVE #####
7 kwanza_1    | {"level":"info","ts":1568120211.728028,"caller":"runner/
      runner.go:71","msg":"expvars available","port":8080}
8 kwanza_1    | {"level":"info","ts":1568120211.7392752,"caller":"runner/
      runner.go:169","msg":"Successfully initialized PostgreSQL registry"}
9 kwanza_1    | {"level":"info","ts":1568120211.7431538,"caller":"runner/
      runner.go:136","msg":"Server started","grpc_port":8001,"http_port"
      :8000}
10 kwanza_1   | {"level":"info","ts":1568120211.7432065,"caller":"runner/
      runner.go:132","msg":"Profiling interface running on port 6060"}
```

Look for hints as to why the Kwanza container will not start as expected. This may include issues such as disk full, low memory, to many open files, corrupt file system, etc. Follow best-pratice for Linux operation and maintenance if you encounter one of these.

Once the issue have been resolved, try to start the container again in attached mode. If startup succeeds, then stop the container and start it again in detached mode `-d` on the `docker-compose up`

command.

## 6 Issue hunting on Cuesta

In order to resolve issues on the Cuesta container, the administrator may follow these steps.

First try to start Cuesta container in attached mode. This will give direct feedback on the process in the console. A normal startup will look similar to this (variations may occur based on the specific version)

```
1 # docker-compose up cuesta
2 deploy_postgres_1 is up-to-date
3 Starting deploy_kwanza_1 ... done
4 Starting deploy_cuesta_1 ... done
5 Attaching to deploy_cuesta_1
6 cuesta_1    | Serving with SSL
```

Look for hints as to why the Cuesta container will not start as expected. This may include issues such as disk full, low memory, too many open files, corrupt file system, etc. Follow best-practice for Linux operation and maintenance if you encounter one of these.

Once the issue have been resolved, try to start the container again in attached mode. If startup succeeds, then stop the container and start it again in detached mode `-d` on the `docker-compose up` command.

## 7 Backup and Restore

The configuration data of Sirenia Automation and Sirenia Context Management is stored in the Postgres Database hosted in the Postgres container. The actual data is stored on a Volumen mounted to the container on container start time. Backing up databases and the ability to restore, is one of the most critical tasks in secure system operation. The administrator should follow best practice for Postgres Database backup and restore.

### 7.1 Backup Kwanza Database

Before backing up the databases, the administrator should consider the following points:

- Full / partial databases
- Both data and structures, or only structures

- Point In Time recovery
- Restore performance

PostgreSQL provides `pg_dump` and `pg_dumpall` tools to help you backup databases easily and effectively. To backup one database, you can use the `pg_dump` tool. The `pg_dump` dumps out the content of all database objects into a single file.

```
1 #pg_dump -U postgres -W -F t kwanza > kwanza.tar
```

- `-U postgres`: specifies the user to connect to PostgreSQL database server.
- `-W`: forces `pg_dump` to prompt for the password before connecting to the PostgreSQL database server.
- `-F t`: specifies the output file format to be tar format.
- `kwanza`: is the name of the database that we want to backup

## 7.2 Restore Kwanza Database

You can use `pg_restore` program to restore databases backed up by the `pg_dump` or `pg_dumpall` tools. With `pg_restore` program, you have various options for restoration databases, for example:

- The `pg_restore` allows you to perform parallel restores using the `-j` option to specify the number of threads for restoration. Each thread restores a separate table simultaneously, which speeds up the process dramatically. Currently, the `pg_restore` support this option for the only custom file format.
- The `pg_restore` enables you to restore specific database objects in a backup file that contains the full database.
- The `pg_restore` can take a database backed up in the older version and restore it in the newer version.

To restore a Kwanza database backup, create a new database named `kwanza`:

```
1 CREATE DATABASE kwanza;
```

You can restore the `kwanza` database in tarfile format generated by the `pg_dump` tool using the following command:

```
1 #pg_restore --dbname=kwanza --verbose kwanza.tar
```

If you restore the database, which is the same as the one that you backed up, you can use the following command:

```
1 #pg_restore --dbname=kwanza --create --verbose kwanza.tar
```