Lab 04 - Docker

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Link forked from here and the version is `28e97b713e2d3803acee5b447dd67596624e11b0`

Introduction

As an introduction, we can say that the goals of this lab are to build our own Docker images, become familiar with process supervision for Docker, understand core concepts for dynamic scaling of an application in production and put into practice decentralised management of web server instances. This lab is built upon the previous lab we did on the load-balancing tool HAProxy.

The lab consists of 6 tasks and one initial task (the initial task should be quick if you already completed the lab on load balancing):

1. Add a process supervisor to run several processes
2. Add a tool to manage membership in the web server cluster
3. React to membership changes
4. Use a template engine to easily generate configuration files
5. Generate a new load balancer configuration when membership changes
6. Make the load balancer automatically reload the new configuration

The introduction task is : Identify issues and install the tools

We then conclude the lab.

Task 0 : Identify issues and install the tools

Questions

[M1] **Do you think we can use the current solution for a production environment? What are the main problems when deploying it in a production environment?** An issue is the latency between the human reaction and the server being down. The fact that the administrator has to perform a check on the servers to kill one and reload it has to create some latency. In the previous lab, we built an architecture that was working fine, but we add to configure the proxy and reload it manually each time. This implies some heavy human interaction and therefore create some latency.

Furthermore, in our previous implementation of the lab, we used the SERVERID cookie session management. In this implementation, such bugs could cause some session losses and therefore, create some inconveniences.

[M2] Describe what you need to do to add new `webapp` container to the infrastructure. Give the exact steps of what you have to do without modifying the way the things are done. Hint: You probably have to modify some configuration and script files in a Docker image. In order to add a new node in our *webapp*, you need to :

1. Add the server in the haconfig, by adding the line server s3 <s3>:3000 check after the *s2* server is declared. (Works in the early stages of the lab. After a few steps, the declaration of *s2* will disappear and therefore this supplementation will no longer be relevant)
2. Add the following line in the run script in the ha/scripts folder.

   ```
   sed -i 's/<s3>/$S3_PORT_3000_TCP_ADDR/g'
   /usr/local/etc/haproxy/haproxy.cfg
   ```

3. In the docker-compose file, add the following under the *s2* declaration :

   ```
   webapp3:
           container_name: ${WEBAPP_3_NAME}
           build:
   ```

approach, more dynamic, could be more than welcome in order to make adding, removing or editing a node easier and faster.

A solution to this issue could be to use a script that creates the new node based on the previous node based on the name created previously. That would simulate the mechanism of auto-increment we want to do.

[M4] You probably noticed that the list of web application nodes is hardcoded in the load balancer configuration. How can we manage the web app nodes in a more dynamic fashion? You could create a script that adds to the configuration file, the name of the node and the info needed dynamically. HaProxy offers a *runtime API* that allows us to do so. A more detailed solution could be found here.

[M5] In the physical or virtual machines of a typical infrastructure we tend to have not only one main process (like the web server or the load balancer) running, but a few additional processes on the side to perform management tasks.

For example to monitor the distributed system as a whole it is common to collect in one centralised place all the logs produced by the different machines. Therefore we need a process running on each machine that will forward the logs to the central place. (We could also imagine a central tool that reaches out to each machine to gather the logs. That's a push vs. pull problem.) It is quite common to see a push mechanism used for this kind of task.

Do you think our current solution is able to run additional management processes beside the main web server / load balancer process in a container? If no, what is missing / required to reach the goal? If yes, how to proceed to run for example a log forwarding process? Our solution does not allow multiple processes to be launched on the same Docker as it goes against the good behaviour of using a Docker image. A way to bypass those barriers is to create a launcher process (ìnit) and launch sub-processes.

Looking at the run (on the right commit version right otherwise the link does not work) , we can see that we use rsyslogd. We could use this command to log everything we need and forward them to a centralised server.

[M6] In our current solution, although the load balancer configuration is changing dynamically, it doesn't follow dynamically the configuration of our distributed system when web servers are added or removed. If we take a closer look at the `run.sh` script, we see two calls to `sed` which will replace two lines in the `haproxy.cfg` configuration file just before we start `haproxy`. You clearly see that the configuration file has two lines and the script will replace these two lines.

What happens if we add more web server nodes? Do you think it is really dynamic? It's far away from being a dynamic configuration. Can you propose a solution to solve this? Whenever we want to add a new node to the server, we have to stop the server, edit *HaProxy*'s configuration file and relaunch the script in order to get the changes to stick to the server.

One way of patching this issue would be using the Runtime API of *HaProxy* and find some kind of solution to patch the problem we created.

Deliverable

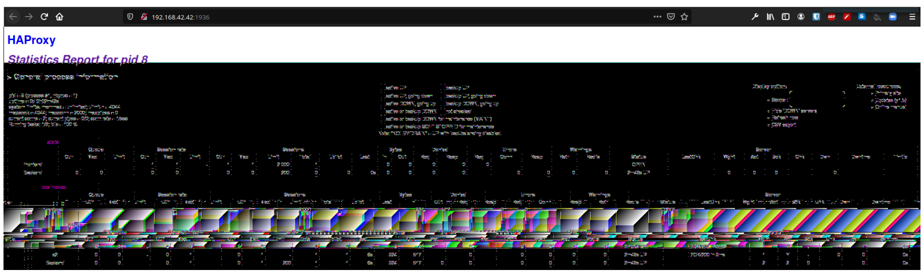


Figure 1: stats

Take a screenshot of the stats page of HAProxy at http://192.168.42.42:1936. You should see your backend nodes.

Question 2 : Describe your difficulties for this task and your understanding of what is happening during this task. Explain in your own words why are we installing a process supervisor. Do not hesitate to do more research and to find more articles on that topic to illustrate the problem.

We did not encounter many difficulties in this part (except the fact that the path were bloated a bit but no big deal). Everything ran smoothly and we did not spend a lot of time doing the manipulations.

As for the installation of a *process supervisor*, we found that it would be useful in order to run multiple processes in the same Docker *container*. As it was stated in the documentation of the lab, Docker is made to run a single process per *container*.

If we want to bypass the single process implementation, we have to start a little process, `init` in our case, that runs as our main process and start other secondaries processes as the multiple processes we need. From there, we set up S6 to manage our processes.

At the end, we can see that the `init` process start the Docker configuration and S6 will manage the other applications processes.

Task 2 : Add a tool to manage membership in the web server cluster

Deliverable 1 : Provide the docker log output for each of the containers: `ha`, `s1` and `s2`. You need to create a folder `logs` in your repository to store the files separately from the lab report. For each lab task create a folder and name it using the task number. No need to create a folder when there are no logs

Check Task 2. The files are called *ha*, *s1* and *s2*

Deliverable 2 : Give the answer to the question about the existing problem the with the current solution.

The existing problem with the current solution is that we create a *cluster* around ha asking the new nodes to join this one first. The problem lies in the fact that if the cluster does not exist while we create a new *node*, it will not work. What we would have wanted to do is that all the new nodes that we create can join the cluster independently of the other nodes.

Deliverable 3 : Give an explanation on how `Serf` is working. Read the official website to get more details about the `GOSSIP` protocol used in `Serf`. Try to find other solutions that can be used to solve similar situations where we need some auto-discovery mechanism.

```
Serf is a decentralized solution for service discovery and orchestration
that is lightweight, highly available, and fault tolerant.
```

This quote from [Serf's github page] means that Serf is a discovery service that allows to detect nodes failures and notify the rest of the cluster. *"An event system is built on top of Serf, letting you use Serf's gossip protocol to propagate events such as deploys, configuration changes, etc. Serf is completely masterless with no single point of failure."*

A GOSSIP protocol is a process of computer peer-to-peer communication based on the spread on an epidemics.

In Serf's case, it means that the nodes will be kept updated about the health and the status of the other nodes. It works in a bidirectional communication between the current node and the cluster. That way, new nodes can join the cluster at any time and their health will be checked on by the other nodes.

As seen here, we can see that a lot of alternatives exist. The most significant would be kubernetes or consul.

Task 3 : React to membership changes

Deliverable 1 : Provide the docker log output for each of the containers: `ha`, `s1` and `s2`. Put your logs in the `logs` directory you created in the previous task.

Check Task 3. The files are called *ha*, *s1* and *s2*.

Deliverable 2 : Provide the logs from the `ha` container gathered directly from the `/var/log/serf.log` file present in the container. Put the logs in the `logs` directory in your repo.

Check Task 3. The file is called *serf.log*.

Task 4 : Use a template engine to easily generate configuration files

Deliverable 1 : You probably noticed when we added `xz-utils`, we have to rebuild the whole image which took some time. What can we do to mitigate that? Take a look at the Docker documentation on image layers. Tell us about the pros and cons to merge as much as possible of the command. In other words, compare:

```
RUN command 1
```

```
RUN command 2
RUN command 3
```

vs.

```
RUN command 1 && command 2 && command 3
```

There are also some articles about techniques to reduce the image size. Try to find them. They are talking about `squashing` or `flattening` images.

Each command we asked the Docker container to do is another layer created. Therefore, it creates a heavier image . Combining multiple commands allows the image to run them simultaneously and therefore reduce the size of the image.

docker−squash allows to reduce the size of the image automatically. Some use cases are available here. This solution is not optimal as some compatibility issues have been reported.

It is also possible to flatten a Docker container :

```
# Flatten a Docker container

# So it is only possible to “”flatten a Docker container,
# not an image. So we need to start a container from an
# image first. Then we can export and import the container
# in one line:

docker export <CONTAINER ID> | \
docker import - some-image-name:latest
```

Source

Deliverable 2 : Propose a different approach to architecture our images to be able to reuse as much as possible what we have done. Your proposition should also try to avoid as much as possible repetitions between your images.

In order to reuse the most things possible in our architecture, we could try to create another image with all the commands that never change throughout the process of building the containers. Therefore, we build it one time and do not have to build it again. You can make inherit the image from a “*mother image*”.

In order to do so, we could use the FROM command in the *daughter images.*

Deliverable 3 : Provide the `/tmp/haproxy.cfg` file generated in the `ha` container after each step. Place the output into the `logs` folder like you already did for the Docker logs in the previous tasks. Three files are expected.

Check Task 4. The file is called *haproxy.cfg* and all the outputs are in the same file. (Instead of three files, they all have been combined in one and comments show where is what.)

In addition, provide a log file containing the output of the `docker ps` console and another file (per container) with `docker inspect`. Four files are expected.

Check Task 4. The files are called *docker_ps.log*, *inspect_ha.log*, *inspect_s1.log* and *inspect_s2.log*

Deliverable 4 : Based on the three output files you have collected, what can you say about the way we generate it? What is the problem if any?

In the docker inspect command, you can pass as a parameter −−format in Go which is useful to trim the output. The fact that we get a JSON output with a lot of *null* values is very verbose. It can be, at time, very heavy and lengthy, therefore, painful to read.

An example of the −−format parameter is :
docker inspect −−format='{{json .Config}}' $INSTANCE_ID. It is useful to get a subsection in JSON format.

Task 5 : Generate a new load balancer configuration when membership changes

Provide the file `/usr/local/etc/haproxy/haproxy.cfg` generated in the `ha` container after each step. Three files are expected.

Check Task 5. The files are called *haproxy_after_s1.cfg*, *haproxy_after_s2.cfg*, *haproxy_before_nodes.cfg* and

In addition, provide a log file containing the output of the `docker ps` console and another file (per container) with `docker inspect`. Four files are expected.

Check Task 5. The files are called *docker_ps.log*, *docker_inspect_ha.log*, *docker_inspect_s1.log* and *docker_inspect_s2.log*

Provide the list of files from the `/nodes` folder inside the `ha` container. One file expected with the command output.

Check Task 5. The file is called *nodes.log*.

Provide the configuration file after you stopped one container and the list of nodes present in the `/nodes` folder. One file expected with the command output. Two files are expected.

Check Task 5. The files are called *haproxy_after_s2_shutdown.cfg* and *nodes_after_s2_shutdown.log*.

In addition, provide a log file containing the output of the `docker ps` console. One file expected.

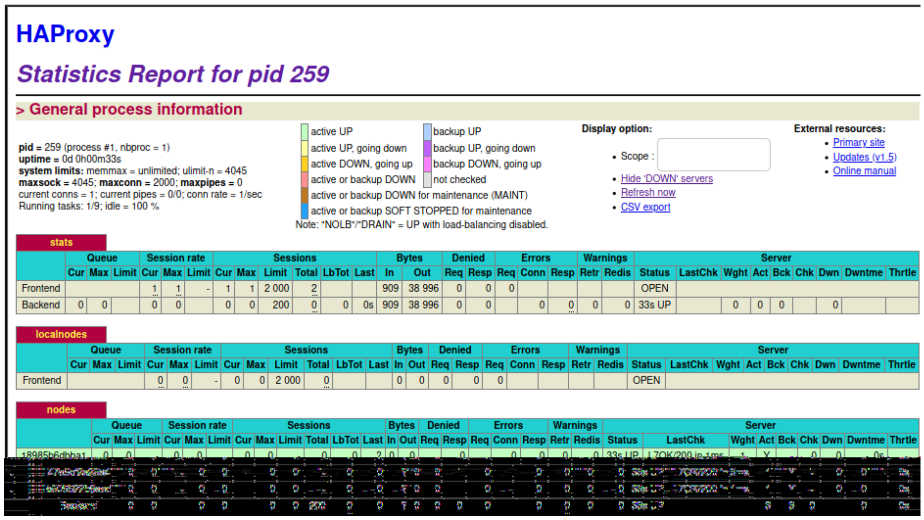
Check Task 5. The file is called *docker_ps_afer_s2_shutdown.log*.

(Optional:) Propose a different approach to manage the list of backend nodes. You do not need to implement it. You can also propose your own tools or the ones you discovered online. In that case, do not forget to cite your references.

Task 6: Make the load balancer automatically reload the new configuration

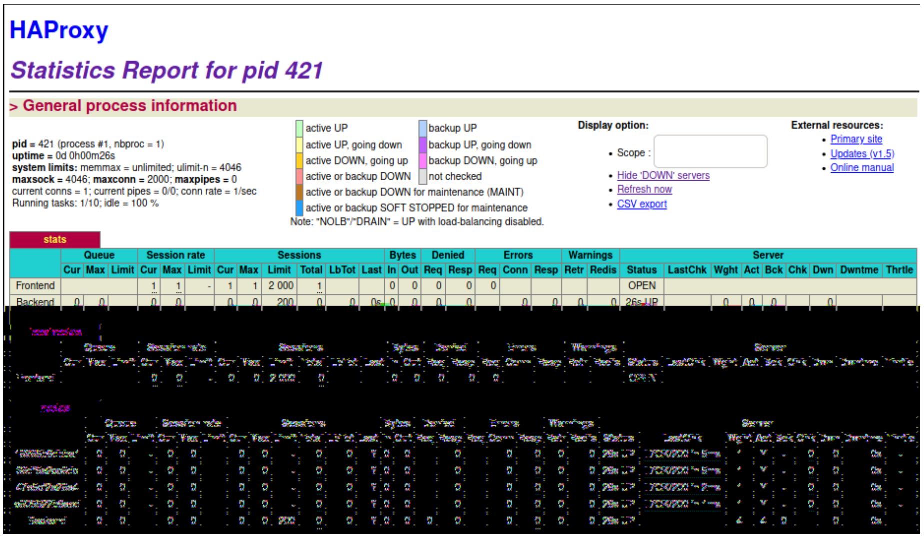
Take a screenshots of the HAProxy stat page showing more than 2 web applications running. Additional screenshots are welcome to see a sequence of experimentation like shutting down a node and starting more nodes.

You can add any number of nodes with the command :
docker run –d ––network heig ––name s<#node> <imageName>



After adding two nodes :

We then remove a node (*S4*) :



Also provide the output of `docker ps` in a log file. At least one file is expected. You can provide one output per step of your experimentation according to your screenshots.

Check Task 6. The file is called *docker_ps.log*.

Give your own feelings about the final solution. Propose improvements or ways to do the things differently. If any, provide references to your readings for the improvements.

The final solution seems to be reactive and adding or deleting backend nodes is easy. One issue we can find on the current solution is that it is the best way to adding or removing only a **backend** node dynamically. We therefore, cannot do the same for the HaProxy container. We have to launch manually the ha container and cannot launch another one on the fly. We should maybe do the same for this container.

(Optional:) Present a live demo where you add and remove a backend container.

The demo has already been done in class to Yann Lederrey on the date of the 06/01/2020 at 14:56,

Conclusion

In conclusion, we achieved everything we wanted to in this lab. We configured a proxy in a dynamic way and that what we basically wanted to do.
We also created the docker images we needed to and mastered all the aspects we wanted to.

We encountered some difficulties because of the lab that was not clear at some point but we came through and all went fine.