MICADO V3 advanced

This page is intended to use for developers.

The tutorial builds a scalable architecture framework with the help of Occopus and performs the automatic scaling of the application based on Occopus, Docker Swarm and Prometheus (a monitoring tool). The scalable architecture framework can be seen in Figure 1.

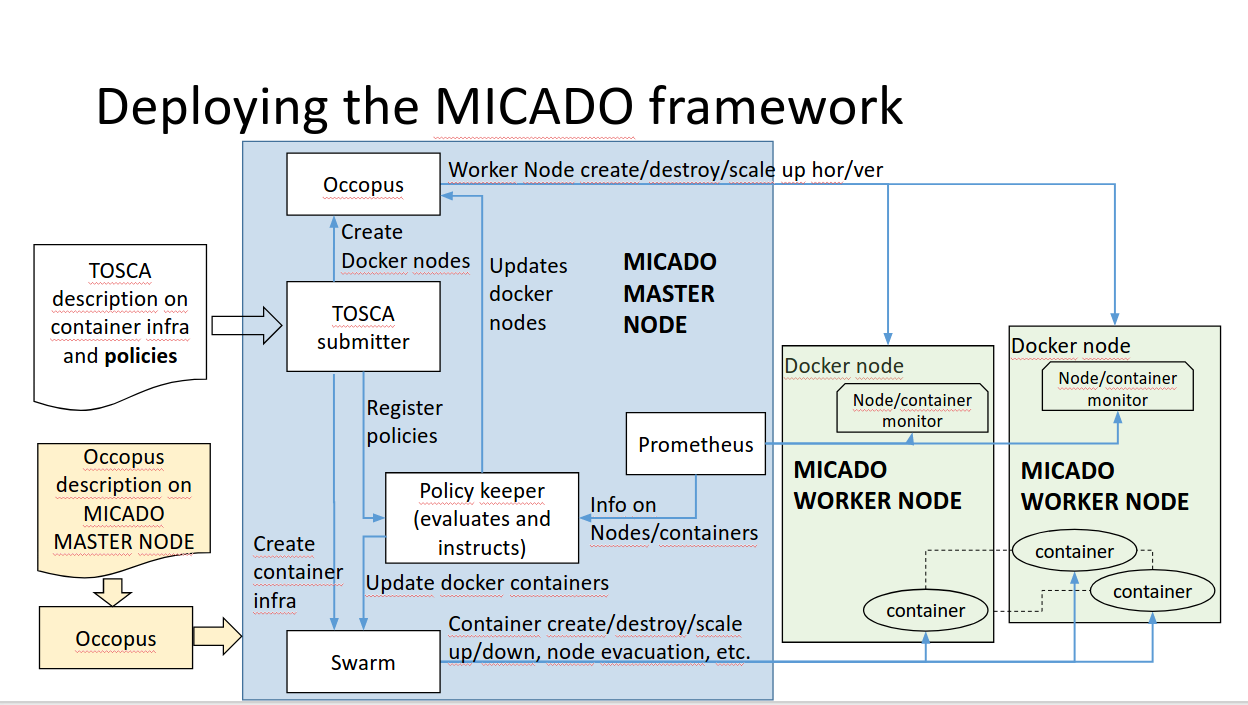


Figure 1. Docker based auto-scaling infrastructure with a separate load balancing layer

The scalable architecture framework consists of the following services:

1. Cloud orchestrator and manager: [Occopus](http://occopus.lpds.sztaki.hu/)
2. Application node: [Data Avenue](https://data-avenue.eu/) (DA)
3. Service discovery: [Consul](https://www.consul.io/)
4. Docker engine: [Docker Swarm](https://docs.docker.com/engine/swarm/)
5. Monitoring tool: [Prometheus](https://prometheus.io/)

In this infrastructure you will see how can you create a docker service in Docker Swarm. This service will be the user application. You can also deploy multiple application to the same infrastructure later if you wish or delete them. In this infrastructure nodes are discovered by Consul, which is a service discovery tool also providing DNS service and are monitored by Prometheus, a monitoring software.

In this demonstration architecture, the Data Avenue (DA) service was selected to be the concrete application. Notice that other applications can easily replace the DA service. The DA service here implements data transfer between the client and a remote storage using various protocols (http, sftp, s3, ...). For further details about the software, please visit [the Data Avenue website](http://data-avenue.eu/en_GB/). Finally, in the lowest layer there is a Database node (not shown in Figure 1) required by the instances of Data Avenue to store and retrieve information (authentication, statistics) for their operation. If you use your own application feel free to delete the database later on.

The monitor service Prometheus collects runtime information about virtual machines and also about the running containers on these machines. The VMs are connected to Docker Swarm. When an application is overloaded, Prometheus instructs Swarm to increment the number of containers for that application. When there is no more resource available in the docker cluster to create new containers, Prometheus calls Occopus to scale up, and create a new virtual machines. The docker based applications can have unlimited resources of the host machines or you can limit the available resource for the containers, which is advised. This will ensure that different applications can work next to each other. If the application service is under loaded, Prometheus instructs first Swarm to decrease the number of containers of that application and if one of the hosts in the cluster gets under loaded too, it will call Occopus to scale down the number of the host machines.

**Advantages of Docker**

- encapsulation

- shorter node description files

- easier maintenance

- OS independent

The biggest advantage of Docker what we will see, is that changing user application is easy. Users don’t have to modify the node description files at all. After logging in the virtual machine which is running Docker Swarm, you can start your own Docker based application in one command.

Features

* using Prometheus to monitor nodes and containers.
* generate application specific alerting rules automatically.
* using load balancers to share system load between application nodes.
* using Consul as a DNS service discovery agent.
* use an alert executor that communicates with Swarm and Occopus to scale running applications and host machines.
* using a docker cluster that is running the applications

Prerequisites

* accessing a cloud through an Occopus-compatible interface (e.g. EC2, OCCI, Nova, etc.)
* target cloud contains a base 16.04 ubuntu LTS OS image with cloud-init support (image id, instance type)
* Components in the infrastructure connect to each other, therefore several port ranges must be opened for the VMs executing the components. Clouds implement port opening various way (e.g. security groups for OpenStack, etc.). Make sure you implement port opening in your cloud for the following port ranges:

TCP 22 (SSH)

TCP 80 (HTTP)

TCP 443 (HTTPS)

TCP 8300 (Consul) TCP Server RPC. This is used by servers to handle incoming requests from other agents.

TCP and UDP 8301 (Consul) This is used to handle gossip in the LAN. Required by all agents.

TCP and UDP 8302 (Consul) This is used by servers to gossip over the WAN to other servers.

TCP 8400 (Consul) CLI RPC. This is used by all agents to handle RPC from the CLI.

TCP 8500 (Consul) HTTP API. This is used by clients to talk to the HTTP API.

TCP and UDP 8600 (Consul) DNS Interface. Used to resolve DNS queries.

TCP 9090 (Prometheus)

TCP 8080 (Data Avenue)

TCP 9093 (Alertmanager)

TCP 9095 (Alert executor)

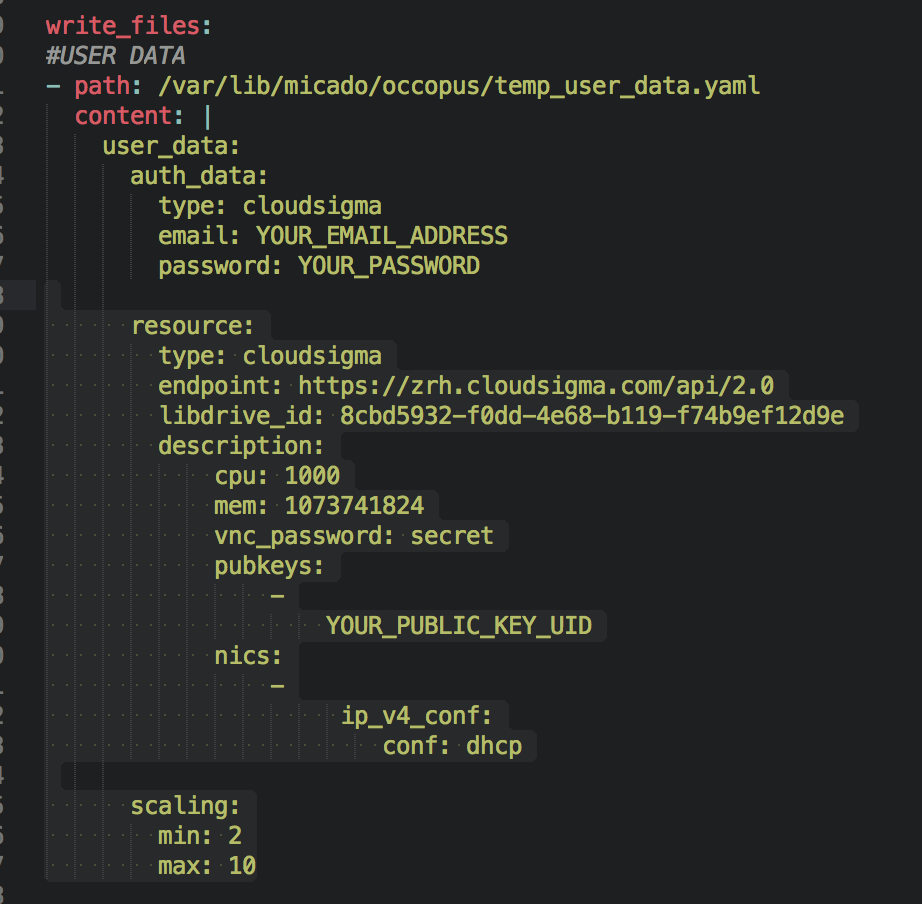
Download base project files

Download the MICADO input file from here: <https://goo.gl/ZhgvUm>

# 2. Deployment of MiCADO

## 2.1 Insert your user imputs

Now you have to modify the file that you downloaded. In the beginning of the file you will see a section called “USER DATA” as shown in this picture:

 This file specifies the user credentials for the target cloud, the resource IDs that will be used for the Virtual machines and a scaling section which specifies the scaling ranges. We provided you an already filled out configuration for the CloudSigma cloud. The only thing you have to change is your email and password credentials the UID of your public key in the “pubkeys” section. (You can find or create your key on Cloudsigma by clicking on the left-hand side on “Access and Security” and then select “key management on the CloudSigma website. You will find the uuid of you key there.). When you are ready save the file and exit.

## 2.3 Start MICADO

To start MICADO click on the “Wizzard” button on the compute tab if you use Cloudsigma.

* Choose the favour type “small-2”
* An Ubuntu 16.04 LTS Image
* Attach your ssh key
* Paste the previously downloaded file to the cloud-init box and activate it.
* The click on “Create”

# **NOTE:** If you wish to use another cloud, the steps should be almost the same.

# Deploy the Application

The infrastructure itself won’t start any application. To start the example DA application or implement your own application follow these steps. First you have to SSH into the VM that runs Docker Swarm which node called Master.

After you logged in, you have to start the application as a Docker service. To start the service type the following command. Look for the place holder!

To start the example Data avenue application (requires sudo privileges!):

docker service create --name dataavenue --limit-cpu=0.6 --publish 80:8080 micado/dataavenue "MICADO IP address."

--name: gives a name to the service which you will find in all the nodes in the Swarm cluster.

– publish port: routes http requests to the applications

– “database IP address”: points the example DA application containers to the database node

– micado/dataavenue: name of the image

– --limit-cpu: a value between 0-1 that limits the cpu usage of the containers.

**Note:** Deploying the DA application takes around 2 minutes. You will be able to reach the application on any of the deployed virtual machine IP address/blacktop3, like:

http://”MICADO IP address”/blacktop3

To start any other application (requires sudo privileges!):

$ Docker service create --name [name\_of\_the\_application] – limit-cpu=”value” --publish [port\_number\_where\_your\_application\_listen]:[port\_on\_which\_you\_want\_to\_reach\_it] -p [host\_port]:[container\_port] [docker\_image]

What you have to keep in mind that Docker containers have a separate network, and you should make sure that you expose the ports on which your application is listening to the virtual machine port. Otherwise you won’t be able to reach your running application.

After you started your service, Docker Swarm will share the load in the Swarm cluster by creating a routing mash. It is created automatically, when you specified the –publish argument. Your applications will be reachable on all of your hosts machines interfaces, and on the port number you published.

**Note:** You can find more info about Docker’s built in load balancer in the following link: <https://docs.Docker.com/engine/swarm/ingress/>

To query the running services and the available nodes in the Swarm cluster run (requires sudo privileges!):

$ docker service list

$ docker node ls

You can also check the status of your alerts during the testing at Prometheus

http://[Master node IP address]:9090/alerts

curl -X POST http://[Occopus\_restservice\_ip]:[Occopus\_restservice\_port]/infrastructures/[infrastructure\_id]/scaleup/app

**Important**

Depending on the cloud you are using for you virtual machines it can take a few minutes to start a new node and connect it to your infrastructure. The connected nodes are present on prometheus’s targets page.

To test the scaling mechanisms with the example DA application put some load on the application nodes with the command below. Just select your master node IP address. The incoming user requests will be shared evenly between the application nodes. Start around 10 copy of the command to generate enough load. After a few minutes the cluster will be overloaded, and the overloaded alerts will fire in Prometheus for the DA application. Swarm will create a new container first, if there is enough resource to do so, and if there is no available resource, a new host machine will be started and connected to your cluster. Also, if you stop sending files for a while, the under loaded alert will fire in Prometheus and one (or more) of the application/load balancer nodes will be shut (scaled) down while Swarm will also decrease the number of containers as well.

To check the status of alerts under Prometheus during the testing, keep watching the following url in your browser:

http://[master node ip]:9090/alerts

To query the running applications and the available node in the cluster on the Master node by Swarm (requires root privileges!)

4. Testing

This section is for testing purposes. If you experience some problems you can find out how to solve it here. TODO

## 4.1 Test if the system is operational

On your browser enter the following URL:

http://ip\_address\_of\_MICADO\_VM:8500

You should see the webpage of Consul. If you see every running service with a green box, you are good to go but if some of them are red, there are some problem. Also on the “nodes” tab you should see at least 3 nodes (MICADO + minimum number of scaling ranges you specified).

## 4.2 Test if the application running properly

You can reach the webpage of the Data Avenue application if you type on your browser the following URL:

http://ip\_address\_of\_MICADO\_VM/blacktop3

## 4.3 Test if scaling working properly

To test the auto scaling feature of MICADO we have to overload the application. To do so we will start many file transfers to our SQL database parallel. Run the following command in many instances on your terminal ( at least 10 copy ). Don’t forget to change the IP address in the command!

$ curl -k -o /dev/null -H "X-Key: 1a7e159a-ffd8-49c8-8b40-549870c70e73" -H "X-URI:https://autoscale.s3.lpds.sztaki.hu/files\_for\_autoscale/1GB.dat" http://[ MICADO IP address]/blacktop3/rest/file

If everything went well in a few minutes you could see VMs booting on your cloud.

To check out the number of nodes after the scale up event in MICADO, check Prometheus on the following link:

<http://ip_address_of_MICADO_VM:9090/targets>

If you have more than 2, then it means that MICADO successfully scaled up the application nodes from 2.

Now we also would like to test if it scales down if there is no load on the cluster. To do so just stop all your file transfers. After a few minutes, the number of nodes in the cluster should be go back to its minimum (2 nodes).

## 4.4 Delete your infrastructure

When you are ready and wish to delete everything, you just need to select the VMs on the cloud and delete them.

Contributing to MICADO can be done on github. Just create a new pull request the one of the admins will merge you changes if everything is fine.

<https://github.com/UniversityOfWestminster/MICADO>

The following video will show how to build up, manage and scale the example application:

<https://youtu.be/DsNBLQTvQFY>