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# MetaK8s Documentation

*Release 0.2.0-dev*

**Scality**

**Jul 23, 2018**



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MetalK8s is an opinionated [Kubernetes](#) distribution with a focus on long-term on-prem deployments, launched by [Scality](#) to deploy its [Zenko](#) solution in customer datacenters.

It is based on the [Kubespray](#) project to reliably install a base Kubernetes cluster, including all dependencies (like [etcd](#)), using the [Ansible](#) provisioning tool. This installation is further augmented with operational tools for monitoring and metering, including [Prometheus](#), [Grafana](#), [ElasticSearch](#) and [Kibana](#). Furthermore, an “ingress controller” is deployed by default, based on [Nginx](#). All of these are managed as [Helm](#) packages. See [Cluster Services](#) for a whole listing.

Unlike hosted Kubernetes solutions, where network-attached storage is available and managed by the provider, we assume no such system to be available in environments where MetalK8s is deployed. As such, we focus on managing node-local storage, and exposing these volumes to containers managed in the cluster. See [Storage Architecture](#) for more information.



See our *Quickstart Guide* to deploy a cluster.

## 1.1 Quickstart Guide

To quickly set up a testing cluster using [MetalK8s](#), you need 3 machines running [CentOS 7.4](#) to which you have SSH access (these can be VMs). Each machine acting as a [Kubernetes](#) node (all of them, in this example) also need to have at least one disk available to provision storage volumes.

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**Todo:** Give some sizing examples

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### 1.1.1 Defining an Inventory

To tell the [Ansible](#)-based deployment system on which machines [MetalK8s](#) should be installed, a so-called *inventory* needs to be provided. This inventory contains a file listing all the hosts comprising the cluster, as well as some configuration.

First, create a directory, e.g. `inventory/quickstart-cluster`, in which the inventory will be stored. For our setup, we need to create two files. One listing all the hosts, aptly called `hosts`:

```
node-01 ansible_host=10.0.0.1 ansible_user=centos
node-02 ansible_host=10.0.0.2 ansible_user=centos
node-03 ansible_host=10.0.0.3 ansible_user=centos

[kube-master]
node-01
node-02
node-03

[etcd]
```

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```
node-01
node-02
node-03
```

```
[kube-node]
```

```
node-01
node-02
node-03
```

```
[k8s-cluster:children]
```

```
kube-node
kube-master
```

Make sure to change IP-addresses, usernames etc. according to your infrastructure.

In a second file, called `kube-node.yml` in a `group_vars` subdirectory of our inventory, we declare how to setup storage (in the default configuration) on hosts in the `kube-node` group, i.e. hosts on which Pods will be scheduled:

```
metalk8s_lvm_drives_vg_metalk8s: ['/dev/vdb']
```

In the above, we assume every `kube-node` host has a disk available as `/dev/vdb` which can be used to set up Kubernetes *PersistentVolumes*. For more information about storage, see [Storage Architecture](#).

## 1.1.2 Upgrading from MetalK8s < 0.2.0

The storage configuration changed in a non-backward compatible way on MetalK8s 0.2.0 release. The old configuration will trigger an error when the playbook `playbooks/deploy.yml` is run.

An old configuration looking like this

```
metal_k8s_lvm:
  vgs:
    kubevg:
      drives: ['/dev/vdb']
```

would become

```
metalk8s_lvm_default_vg: False
metalk8s_lvm_vgs: ['kubevg']
metalk8s_lvm_drives_kubevg: ['/dev/vdb']
metalk8s_lvm_lvs_kubevg:
  lv01:
    size: 52G
  lv02:
    size: 52G
  lv03:
    size: 52G
  lv04:
    size: 11G
  lv05:
    size: 11G
  lv06:
    size: 11G
  lv07:
    size: 5G
```

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```
lv08:
  size: 5G
```

A quick explanation of these new variables and why they are required

- `metalk8s_lvm_default_vg`: The value `False` will ensure that we disable all automatic logic behind configuring the storage
- `metalk8s_lvm_vgs`: This is a list of the LVM VGs managed by MetalK8s
- `metalk8s_lvm_drives_kubevg`: This variable is a concatenation of the prefix `metalk8s_lvm_drives_` and the name of the LVM VG. It is used to specify the drives used for this LVM VG
- `metalk8s_lvm_lvs_kubevg`: This variable is a concatenation of the prefix `metalk8s_lvm_lvs_` and the name of the LVM VG. It is used to specify the LVM LVs created in this LVM VG.

### 1.1.3 Entering the MetalK8s Shell

To easily install a supported version of Ansible and its dependencies, as well as some Kubernetes tools (**kubectl** and **helm**), we provide a **make** target which installs these in a local environment. To enter this environment, run **make shell** (this takes a couple of seconds on first run):

```
$ make shell
Creating virtualenv...
Installing Python dependencies...
Downloading kubectl...
Downloading Helm...
Launching MetalK8s shell environment. Run 'exit' to quit.
(metal-k8s) $
```

Now we're all set to deploy a cluster:

```
(metal-k8s) $ ansible-playbook -i inventory/quickstart-cluster -b playbooks/deploy.yml
```

Grab a coffee and wait for deployment to end.

### 1.1.4 Inspecting the cluster

Once deployment finished, a file containing credentials to access the cluster is created: `inventory/quickstart-cluster/artifacts/admin.conf`. We can export this location in the shell such that the **kubectl** and **helm** tools know how to contact the cluster *kube-master* nodes, and authenticate properly:

```
(metal-k8s) $ export KUBECONFIG=`pwd`/inventory/quickstart-cluster/artifacts/admin.
↪conf
```

Now, assuming port `6443` on the first *kube-master* node is reachable from your system, we can e.g. list the nodes:

```
(metal-k8s) $ kubectl get nodes
NAME          STATUS    ROLES          AGE      VERSION
node-01       Ready    master,node    1m       v1.9.5+coreos.0
node-02       Ready    master,node    1m       v1.9.5+coreos.0
node-03       Ready    master,node    1m       v1.9.5+coreos.0
```

or list all pods:

```
(metal-k8s) $ kubectl get pods --all-namespaces
NAMESPACE          NAME                                READY   ̀
↳STATUS           RESTARTS   AGE
kube-ingress      nginx-ingress-controller-9d8jh      1/1     ̀
↳Running          0           1m
kube-ingress      nginx-ingress-controller-d7vvg      1/1     ̀
↳Running          0           1m
kube-ingress      nginx-ingress-controller-m8jpb      1/1     ̀
↳Running          0           1m
kube-ingress      nginx-ingress-default-backend-6664bc64c9-xsws5 1/1     ̀
↳Running          0           1m
kube-ops           alertmanager-kube-prometheus-0      2/2     ̀
↳Running          0           2m
kube-ops           alertmanager-kube-prometheus-1      2/2     ̀
↳Running          0           2m
kube-ops           es-client-7cf569f5d8-2z974          1/1     ̀
↳Running          0           2m
kube-ops           es-client-7cf569f5d8-qq4h2          1/1     ̀
↳Running          0           2m
kube-ops           es-data-cd5446fff-pkmhn             1/1     ̀
↳Running          0           2m
kube-ops           es-data-cd5446fff-zzd2h             1/1     ̀
↳Running          0           2m
kube-ops           es-exporter-elasticsearch-exporter-7df5bcf58b-k9fdd 1/1     ̀
↳Running          3           1m
...

```

Similarly, we can list all deployed [Helm](#) applications:

```
(metal-k8s) $ helm list
NAME                REVISION   UPDATED                               STATUS   ̀
↳ CHART            NAMESPACE
es-exporter         3          Wed Apr 25 23:10:13 2018      DEPLOYED  ̀
↳ elasticsearch-exporter-0.1.2  kube-ops
fluentd             3          Wed Apr 25 23:09:59 2018      DEPLOYED  ̀
↳ fluentd-elasticsearch-0.1.4  kube-ops
heapster            3          Wed Apr 25 23:09:37 2018      DEPLOYED  ̀
↳ heapster-0.2.7             kube-system
kibana              3          Wed Apr 25 23:10:06 2018      DEPLOYED  ̀
↳ kibana-0.2.2              kube-ops
kube-prometheus     3          Wed Apr 25 23:09:22 2018      DEPLOYED  ̀
↳ kube-prometheus-0.0.33     kube-ops
nginx-ingress       3          Wed Apr 25 23:09:09 2018      DEPLOYED  ̀
↳ nginx-ingress-0.11.1      kube-ingress
prometheus-operator 3          Wed Apr 25 23:09:14 2018      DEPLOYED  ̀
↳ prometheus-operator-0.0.15  kube-ops

```

### 1.1.5 Cluster Services

Various services to operate and monitor your MetalK8s cluster are provided. To access these, first create a secure tunnel into your cluster by running `kubectl proxy`. Then, while the tunnel is up and running, the following tools are available:

Service	Role	Link	Notes
Kubernetes dashboard	A general purpose, web-based UI for Kubernetes clusters	<a href="http://localhost:8001/api/v1/namespaces/kube-system/services/https:kubernetes-dashboard:/proxy/">http://localhost:8001/api/v1/namespaces/kube-system/services/https:kubernetes-dashboard:/proxy/</a>	
Grafana	Monitoring dashboards for cluster services	<a href="http://localhost:8001/api/v1/namespaces/kube-ops/services/kube-prometheus-grafana:http/proxy/">http://localhost:8001/api/v1/namespaces/kube-ops/services/kube-prometheus-grafana:http/proxy/</a>	
Cerebro	An administration and monitoring console for Elasticsearch clusters	<a href="http://localhost:8001/api/v1/namespaces/kube-ops/services/cerebro:http/proxy/">http://localhost:8001/api/v1/namespaces/kube-ops/services/cerebro:http/proxy/</a>	When accessing Cerebro, connect it to <a href="http://elasticsearch:9200">http://elasticsearch:9200</a> to operate the MetalK8s Elasticsearch cluster.
Kibana	A search console for logs indexed in Elasticsearch	<a href="http://localhost:8001/api/v1/namespaces/kube-ops/services/http:kibana:/proxy/">http://localhost:8001/api/v1/namespaces/kube-ops/services/http:kibana:/proxy/</a>	When accessing Kibana for the first time, set up an <i>index pattern</i> for the <code>logstash-*</code> index, using the <code>@timestamp</code> field as <i>Time Filter field name</i> .

See *Cluster Services* for more information about these services and their configuration.

## 1.2 Architecture

### 1.2.1 Cluster Services

A Kubernetes cluster deployed on the Google Cloud Platform using GKE, on Microsoft Azure using AKS or even using Kops or similar tools on Amazon AWS comes with built-in tooling for centralized container log management, metrics collection, tracing, node health checking and more.

In MetalK8s, we augment a basic Kubernetes cluster deployed using the Kubespray playbook) with various tools to bring an on-premise cluster to the same level of operability.

#### Basic Cluster Addons

On top of the basic Kubernetes services, the following addons are deployed:

##### Helm / Tiller

Helm is a *package manager* for Kubernetes. It can be used to deploy various services in a Kubernetes cluster using templates to describe objects. Tiller is a cluster-side service used by the `helm` CLI tool to manage these deployments.

##### Heapster

Heapster is a service which collects and exposes resource consumption metrics of containers running in a cluster. The Kubernetes Dashboard uses the Heapster service, when available, to display CPU and memory usage of Pods, Deployments and more.

### metrics-server

The `metrics-server` service is derived from Heapster, and provides an implementation of the [Metrics API](#) exposing CPU and memory consumption of containers. These metrics are in turn used by the [HorizontalPodAutoscaler](#) controller.

### Ingress Controller

To expose [Services](#) to the outside world using an [Ingress](#) object, Kubernetes requires an [Ingress Controller](#) to be running in the cluster. For this purpose, MetalK8s deploys the `nginx-ingress-controller`, which uses the well-known [Nginx](#) HTTP server under the hood.

### Metering / Monitoring

Metering and monitoring of a MetalK8s cluster is handled by the [Prometheus](#) stack, including the Prometheus TSDB for metrics storage, [Alertmanager](#) to send alerts when preconfigured conditions are (not) met, and [Grafana](#) to visualize stored metrics using predefined dashboards.

### prometheus-operator

The [CoreOS Prometheus Operator](#) is deployed in the cluster to manage Prometheus instances, scrape targets and alerting rules.

### kube-prometheus

We use `kube-prometheus` to provide operational insight into the Kubernetes cluster and containers managed by it. This includes predefined alerting rules and various Grafana dashboards.

*kube-prometheus* uses *prometheus-operator* to deploy all required services.

### node-exporter

The `node-exporter` service is deployed to expose various node OS metrics, which are in turn captured by Prometheus. These metrics include CPU, memory, disk and network consumption as well as many Linux-specific values.

### Grafana

To ease cluster operations, several Grafana dashboards are made available, including cluster-wide views and health-checks, node OS metrics, per-*Deployment* or per-*Pod* resource usage, monitoring of the Prometheus service itself, and many more.

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**Todo:** Do we need to list all exported deployed with kube-prometheus?

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## Log Collection

### ElasticSearch

The [ElasticSearch](#) full-text indexing service is used to ingest all container logs in a central place, and make them accessible to operators. This ElasticSearch cluster is deployed using the [Helm chart](#), with a configuration tuned for production-grade settings.

### Cerebro

The [Cerebro](#) dashboard is a monitoring and administration tool for Elasticsearch clusters.

### ElasticSearch Curator

To ensure ingested logs don't flood the ElasticSearch resources, [ElasticSearch Curator](#) is deployed with a default configuration which drops `logstash-*` indices on a given schedule.

### Fluent Bit and fluentd

The [Fluent Bit](#) service is deployed as a [DaemonSet](#) to stream all container logs into [fluentd](#) instances, which collect them and submit batches to Elasticsearch.

In MetalK8s, Fluent Bit and **fluentd** have a role similar to [Logstash](#) in the *ELK* stack.

### Kibana

To give operators access to the logs stored in ElasticSearch, a [Kibana](#) instance is provided.

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**Note:** When accessing Kibana for the first time, an *index pattern* for the `logstash-*` indices needs to be configured, using `@timestamp` as *Time Filter field name*.

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## 1.2.2 Storage Architecture

MetalK8s current storage architecture rely on local storage, configured with LVM for its purpose.

A default setup, satisfying the storage needs of MetalK8s is automatically setup by default and can be easily extended through the various configuration items exposed by the tool.

### Glossary

- LVM PV: The LVM Physical Volume. This is the disk or the partition provided to LVM to create the LVM Volume Group
- LVM VG : The LVM Volume Group. This is the logical unit of LVM aggregating the LVM Physical Volumes into one single logical entity
- LVM LV: A Logical Volume. This is where the filesystem will be created. Several LVM LVs can be created on a single LVM VG

- PV : Kubernetes Persistent Volume. This is what will be consumed by a Persistent Volume Claim for the Kubernetes storage needs
- PVC : Kubernetes Persistent Volume Claim

### Goal

MetalK8s provides a functional Kubernetes cluster with some opinionated deployment for the monitoring and logging aspect. These deployments require storage, but we wanted to provide an easy way for the end user to add it's own configuration

As the deployment of Kubernetes on premise is focused on dedicated hardware, Logical Volume Manager (LVM) has been chosen.

## 1.3 Changes in MetalK8s

- *Release 0.2.0 (in development)*
  - *Breaking changes*
- *Release 0.1.2 (in development)*
  - *Features added*
  - *Bugs fixed*
- *Release 0.1.1*
  - *Features added*
  - *Bugs fixed*
- *Release 0.1.0*
  - *Incompatible changes*
  - *Features added*
  - *Known issues*

### 1.3.1 Release 0.2.0 (in development)

#### Breaking changes

PR #159 - use upstream chart for Elasticsearch. Historical log data will be lost. Please see the pull-request description for manual steps required after upgrading a MetalK8s 0.1 cluster to MetalK8s 0.2 (#147)

PR #94 - flatten the storage configuration and allow more user defined storage related actions. Please see *Upgrading from MetalK8s < 0.2.0* (#153)

### 1.3.2 Release 0.1.2 (in development)

#### Features added

PR #144 - update Kibana chart version

PR #145 - update the Cerebro chart, and pre-configure the MetalK8s Elasticsearch cluster

PR #154 - rework log collection architecture, now using [Fluent Bit](#) to capture logs, then forward to [fluentd](#) to aggregate them and batch-insert in Elasticsearch (#51)

PR #163 - update versions of Elasticsearch Exporter, *nginx-ingress*, *kube-prometheus* and Kubespray

#### Bugs fixed

PR #151 - fix *debug* clause *var* scoping

#150 - fix deployment of Elasticsearch, node and Prometheus Grafana dashboards (PR #158)

#139 - stabilize `helm init` (PR #167)

### 1.3.3 Release 0.1.1

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**Note:** Compatibility with future releases of MetalK8s is not guaranteed until version 1.0.0 is available. When deploying a cluster using pre-1.0 versions of this package, you may need to redeploy later.

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#### Features added

PR #11 - run the OpenStack [ansible-hardening](#) role on nodes to apply security hardening configurations from the Security Technical Implementation Guide (STIG) (#88)

PR #127 - deploy [Cerebro](#) to manage the Elasticsearch cluster (#126)

PR #138 - update versions of [Fluentd](#), [Kibana](#), [Elasticsearch Exporter](#) and [Kubespray](#)

PR #140 - set up [kube-prometheus](#) to monitor [CoreDNS](#) (cfr. PR #104)

#### Bugs fixed

#103 - set up host anti-affinity for Elasticsearch service scheduling (PR #113)

#120 - required facts not gathered when running the *services* playbook in isolation (PR #132)

PR #134 - fix *bash-completion* in the MetalK8s Docker image

### 1.3.4 Release 0.1.0

This marks the first release of [MetalK8s](#).

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**Note:** Compatibility with future releases of MetalK8s is not guaranteed until version 1.0.0 is available. When deploying a cluster using pre-1.0 versions of this package, you may need to redeploy later.

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### Incompatible changes

PR #106 - the Ansible playbook which used to be called `metal-k8s.yml` has been moved to `playbooks/deploy.yml`

### Features added

PR #100 - disable Elasticsearch deployment by setting `metalk8s_elasticsearch_enabled` to `false` (#98)

PR #104 - `kube-proxy` now uses `ipvs` instead of `iptables` to route `Service` addresses, in preparation for Kubernetes 1.11. The `ipvsadm` tool is installed on all `k8s-cluster` hosts.

PR #104 - use CoreDNS instead of kubedns for in-cluster DNS services, in preparation for Kubernetes 1.11.

PR #113 - deploy the Prometheus `node_exporter` on `k8s-cluster` and `etcd` hosts instead of using a `DaemonSet`

### Known issues

#62 - Elasticsearch Curator may not properly prune old `logstash-*` indices



## CHAPTER 2

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### Indices and tables

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- `genindex`
- `modindex`
- `search`