CONTENTS

Prerequisites

Step 1 — Creating a Namespace

Step 2 — Creating the Elasticsearch StatefulSet

Step 3 — Creating the Kibana Deployment and Service

Step 4 — Creating the Fluentd DaemonSet

Step 5 (Optional) — Testing Container Logging

Conclusion

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How To Set Up an Elasticsearch, Fluentd and Kibana (EFK) Logging Stack on Kubernetes

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K Elasticsearch Solutions Logging

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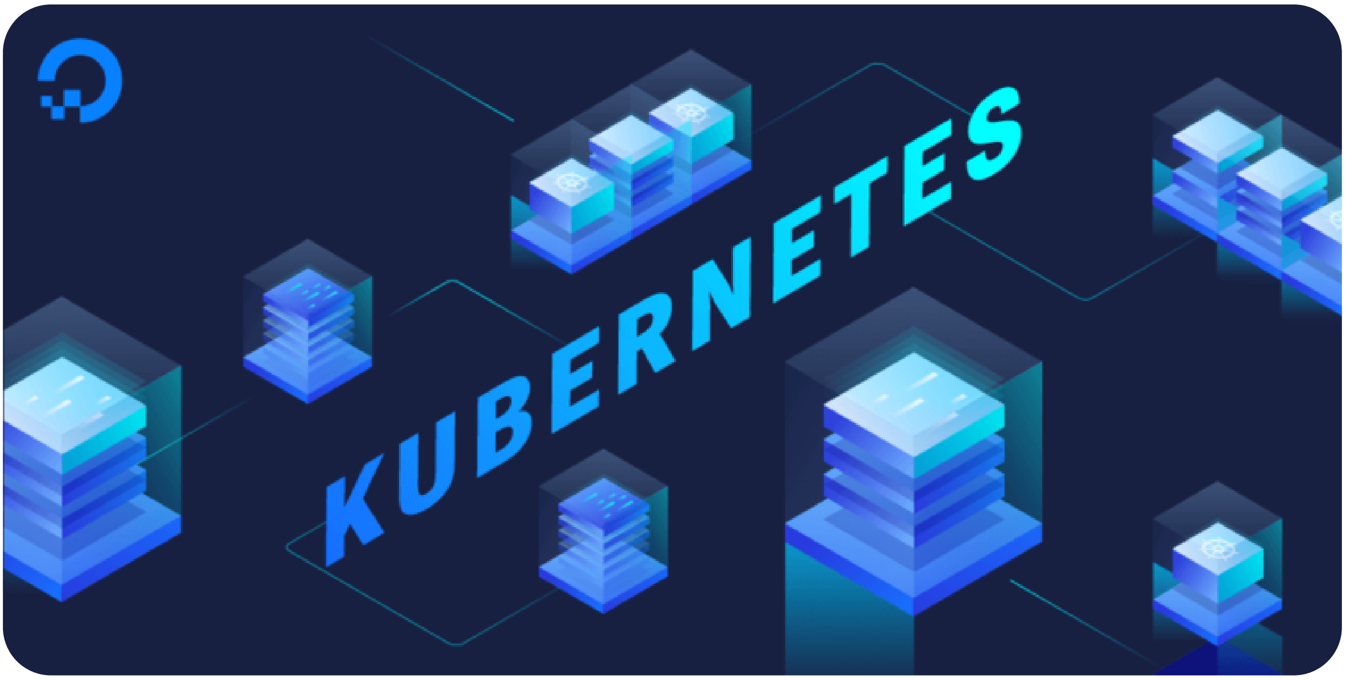
English



Introduction

When running multiple services and applications on a Kubernetes cluster, a centralized, cluster-level logging stack can help you quickly sort through and analyze the heavy volume of log data produced by your Pods. One popular centralized logging solution is the **E**lasticsearch, **F**luentd, and **K**ibana (EFK) stack.

Elasticsearch is a real-time, distributed, and scalable search engine which allows for full-text and structured search, as well as analytics. It is commonly used to index and search through large volumes of log data, but can also be used to search many different kinds of documents.

Elasticsearch is commonly deployed alongside **Kibana**, a powerful data visualization frontend and dashboard for Elasticsearch. Kibana allows you to explore your Elasticsearch log data through a web interface, and build dashboards and queries to quickly answer questions and gain insight into your Kubernetes applications.

In this tutorial we'll use **Fluentd** to collect, transform, and ship log data to the Elasticsearch backend. Fluentd is a popular open-source data collector that we'll set up on our Kubernetes nodes to tail container log files, filter and transform the log data, and deliver it to the Elasticsearch cluster, where it will be indexed and stored.

We'll begin by configuring and launching a scalable Elasticsearch cluster, and then create a Kibana Kubernetes Service and Deployment. To conclude, we'll set up Fluentd as a DaemonSet so it runs on every Kubernetes worker node.

Prerequisites

Before you begin with this guide, ensure you have the following available to you:

- A Kubernetes 1.10+ cluster with role-based access control (RBAC) enabled
    - Ensure your cluster has enough resources available to roll out the EFK stack, and if not scale your cluster by adding worker nodes. We'll be deploying a 3-Pod Elasticsearch cluster (you can scale this down to 1 if necessary), as well as a single Kibana Pod. Every worker node will also run a Fluentd Pod. The cluster in this guide consists of 3 worker nodes and a managed control plane.
- The `kubectl` command-line tool installed on your local machine, configured to connect to your cluster. You can read more about installing `kubectl` [in the official documentation](https://kubernetes.io/docs/tasks/tools/install-kubectl/).

Once you have these components set up, you're ready to begin with this guide.

Step 1 — Creating a Namespace

Before we roll out an Elasticsearch cluster, we'll first create a Namespace into which we'll install all of our logging instrumentation. Kubernetes lets you separate objects running in your cluster using a "virtual cluster" abstraction called Namespaces. In this guide, we'll create a `kube-logging` namespace into which we'll install the EFK stack components. This Namespace will also allow us to quickly clean up and remove the logging stack without any loss of function to the Kubernetes cluster.

To begin, first investigate the existing Namespaces in your cluster using `kubectl`:

```
$ kubectl get namespaces
```

Copy

You should see the following three initial Namespaces, which come preinstalled with your Kubernetes cluster:

```
Output
NAME          STATUS    AGE
default       Active    5m
kube-system   Active    5m
kube-public   Active    5m
```

The `default` Namespace houses objects that are created without specifying a Namespace. The `kube-system` Namespace contains objects created and used by the Kubernetes system, like `kube-dns`, `kube-proxy`, and `kubernetes-dashb` practice to keep this Namespace clean and not pollute it with your application and instrumentation workloads.

The `kube-public` Namespace is another automatically created Namespace that can be used to store objects you'd like to be readable and accessible throughout the whole cluster, even to unauthenticated users.

To create the `kube-logging` Namespace, first open and edit a file called `kube-logging.yaml` using your favorite editor, such as nano:

```
$ nano kube-logging.yaml
```

Copy

Inside your editor, paste the following Namespace object YAML:

kube-logging.yaml

```
kind: Namespace
apiVersion: v1
metadata:
  name: kube-logging
```

Then, save and close the file.

Here, we specify the Kubernetes object's `kind` as a `Namespace` object. To learn more about `Namespace` objects, consult the [Namespaces Walkthrough] in the official Kubernetes documentation. We also specify the Kubernetes API version used to create the object (`v1`), and give it a `name`, `kube-logging`.

Once you've created the `kube-logging.yaml` Namespace object file, create the Namespace using `kubectl create` with the `-f` filename flag:

```
$ kubectl create -f kube-logging.yaml
```

Copy

You should see the following output:

```
Output
namespace/kube-logging created
```

You can then confirm that the Namespace was successfully created:

```
$ kubectl get namespaces
```

Copy

At this point, you should see the new `kube-logging` Namespace:

```
Output
NAME           STATUS    AGE
default        Active    23m
kube-logging   Active    1m
kube-public    Active    23m
kube-system    Active    23m
```

We can now deploy an Elasticsearch cluster into this isolated logging Namespace.

Step 2 – Creating the Elasticsearch StatefulSet

Now that we've created a Namespace to house our logging stack, we can begin rolling out its various components. We'll first begin by deploying a 3-node Elasticsearch cluster.

In this guide, we use 3 Elasticsearch Pods to avoid the "split-brain" issue that occurs in highly-available, multi-node clusters. At a high-level, "split-brain" is what arises when one or more nodes can't communicate with the others, and several "split" masters get elected. With 3 nodes, if one gets disconnected from the cluster temporarily, the other two nodes can elect a new master and the cluster can continue functioning while the last node attempts to rejoin. To learn more, consult A new era for cluster coordination in Elasticsearch and Voting configurations.

Creating the Headless Service

To start, we'll create a headless Kubernetes service called `elasticsearch` that will define a DNS domain for the 3 Pods. A headless service does not perform load balancing or have a static IP; to learn more about headless services, consult the official Kubernetes documentation.

Open a file called `elasticsearch_svc.yaml` using your favorite editor:

```
$ nano elasticsearch_svc.yaml
```

Copy

Paste in the following Kubernetes service YAML:

elasticsearch_svc.yaml

```
kind: Service
apiVersion: v1
metadata:
  name: elasticsearch
  namespace: kube-logging
  labels:
    app: elasticsearch
spec:
```

```
  selector:
    app: elasticsearch
  clusterIP: None
  ports:
    - port: 9200
      name: rest
    - port: 9300
      name: inter-node
```

Then, save and close the file.

We define a `Service` called `elasticsearch` in the `kube-logging` Namespace, and give it the `app: elasticsearch` label. We then set the `.spec.selector` to `app: elasticsearch` so that the Service selects Pods with the `app: elasticsearch` label. When we associate our Elasticsearch StatefulSet with this Service, the Service will return DNS A records that point to Elasticsearch Pods with the `app: elasticsearch` label.

We then set `clusterIP: None`, which renders the service headless. Finally, we define ports `9200` and `9300` which are used to interact with the REST API, and for inter-node communication, respectively.

Create the service using `kubectl`:

```
$ kubectl create -f elasticsearch_svc.yaml
```

Copy

You should see the following output:

```
Output
service/elasticsearch created
```

Finally, double-check that the service was successfully created using `kubectl get`:

```
kubectl get services --namespace=kube-logging
```

You should see the following:

```
Output
NAME            TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)             AGE
elasticsearch   ClusterIP   None         <none>        9200/TCP,9300/TCP   26s
```

Now that we've set up our headless service and a stable `.elasticsearch.kube-logging.svc.cluster.local` domain for our Pods, we can go ahead and create the StatefulSet.

Creating the StatefulSet

A Kubernetes StatefulSet allows you to assign a stable identity to Pods and grant them stable, persistent storage. Elasticsearch requires stable storage to persist data across Pod rescheduling and restarts. To learn more about the StatefulSet workload, consult the Statefulsets page from the Kubernetes docs.

Open a file called `elasticsearch_statefulset.yaml` in your favorite editor:

```
$ nano elasticsearch_statefulset.yaml
```

Copy

We will move through the StatefulSet object definition section by section, pasting blocks into this file.

Begin by pasting in the following block:

elasticsearch_statefulset.yaml

```
apiVersion: apps/v1
kind: StatefulSet
metadata:
  name: es-cluster
  namespace: kube-logging
spec:
  serviceName: elasticsearch
  replicas: 3
  selector:
    matchLabels:
      app: elasticsearch
  template:
    metadata:
      labels:
        app: elasticsearch
```

In this block, we define a StatefulSet called `es-cluster` in the `kube-logging` namespace. We then associate it with our previously created `elasticsearch` Service using the `serviceName` field. This ensures that each Pod in the StatefulSet will be accessible using the following DNS address: `es-cluster-[0,1,2].elasticsearch.kube-logging.svc.cluster.local`, where `[0,1,2]` corresponds to the Pod's assigned integer ordinal.

We specify 3 `replicas` (Pods) and set the `matchLabels` selector to `app: elasticseach`, which we then mirror in the `.spec.template.metadata` section. The `.spec.selector.matchLabels` and `.spec.template.metadata.labels` fields must match.

We can now move on to the object spec. Paste in the following block of YAML immediately below the preceding block:

elasticsearch_statefulset.yaml

```
. . .
    spec:
      containers:
      - name: elasticsearch
        image: docker.elastic.co/elasticsearch/elasticsearch:7.2.0
        resources:
            limits:
              cpu: 1000m
            requests:
              cpu: 100m
        ports:
        - containerPort: 9200
          name: rest
          protocol: TCP
        - containerPort: 9300
          name: inter-node
          protocol: TCP
        volumeMounts:
        - name: data
          mountPath: /usr/share/elasticsearch/data
        env:
          - name: cluster.name
            value: k8s-logs
          - name: node.name
            valueFrom:
              fieldRef:
                fieldPath: metadata.name
          - name: discovery.seed_hosts
            value: "es-cluster-0.elasticsearch,es-cluster-1.elasticsearch,es-c
          - name: cluster.initial_master_nodes
            value: "es-cluster-0,es-cluster-1,es-cluster-2"
          - name: ES_JAVA_OPTS
            value: "-Xms512m -Xmx512m"
```

Here we define the Pods in the StatefulSet. We name the containers `elasticsearch` and choose the `docker.elastic.co/elasticsearch/elasticsearch:7.2.0` Docker image. At this point, you may modify this image tag to correspond to your own internal Elasticsearch image, or a different version. Note that for the purposes of this guide, only Elasticsearch `7.2.0` has been tested.

We then use the `resources` field to specify that the container needs at least 0.1 vCPU guaranteed to it, and can burst up to 1 vCPU (which limits the Pod's resource usage when performing an initial large ingest or dealing with a load spike). You should modify these values depending on your anticipated load and available resources. To learn more about resource requests and limits, consult the official [Kubernetes Documentation](https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/).

We then open and name ports `9200` and `9300` for REST API and inter-node communication, respectively. We specify a `volumeMount` called `data` that will mount the PersistentVolume named `data` to the container at the path `/usr/share/elasticsearch/data`. We will define the VolumeClaims for this StatefulSet in a later YAML block.

Finally, we set some environment variables in the container:

- `cluster.name`: The Elasticsearch cluster's name, which in this guide is `k8s-logs`.
- `node.name`: The node's name, which we set to the `.metadata.name` field using `valueFrom`. This will resolve to `es-cluster-[0,1,2]`, depending on the node's assigned ordinal.
- `discovery.seed_hosts`: This field sets a list of master-eligible nodes in the cluster that will seed the node discovery process. In this guide, thanks to the headless service we configured earlier, our Pods have domains of the form `es-cluster-[0,1,2].elasticsearch.kube-logging.svc.cluster.local`, so we set this variable accordingly. Using local namespace Kubernetes DNS resolution, we can shorten this to `es-cluster-[0,1,2].elasticsearch`. To learn more about Elasticsearch discovery, consult the official Elasticsearch documentation.
- `cluster.initial_master_nodes`: This field also specifies a list of master-eligible nodes that will participate in the master election process. Note that for this field you should identify nodes by their `node.name`, and not their hostnames.
- `ES_JAVA_OPTS`: Here we set this to `-Xms512m -Xmx512m` which tells the JVM to use a minimum and maximum heap size of 512 MB. You should tune these parameters depending on your cluster's resource availability and needs. To learn more, consult Setting the heap size.

The next block we'll paste in looks as follows:

elasticsearch_statefulset.yaml

```
. . .
      initContainers:
      - name: fix-permissions
        image: busybox
        command: ["sh", "-c", "chown -R 1000:1000 /usr/share/elasticsearch/dat
        securityContext:
          privileged: true
        volumeMounts:
        - name: data
          mountPath: /usr/share/elasticsearch/data
      - name: increase-vm-max-map
        image: busybox
        command: ["sysctl", "-w", "vm.max_map_count=262144"]
        securityContext:
          privileged: true
      - name: increase-fd-ulimit
        image: busybox
```

```
        command: ["sh", "-c", "ulimit -n 65536"]
        securityContext:
          privileged: true
```

In this block, we define several Init Containers that run before the main `elasticsearch` app container. These Init Containers each run to completion in the order they are defined. To learn more about Init Containers, consult the official [Kubernetes Documentation].

The first, named `fix-permissions`, runs a `chown` command to change the owner and group of the Elasticsearch data directory to `1000:1000`, the Elasticsearch user's UID. By default Kubernetes mounts the data directory as `root`, which renders it inaccessible to Elasticsearch. To learn more about this step, consult Elasticsearch's "Notes for production use and defaults."

The second, named `increase-vm-max-map`, runs a command to increase the operating system's limits on mmap counts, which by default may be too low, resulting in out of memory errors. To learn more about this step, consult the official Elasticsearch documentation.

The next Init Container to run is `increase-fd-ulimit`, which runs the `ulimit` command to increase the maximum number of open file descriptors. To learn more about this step, consult the "Notes for Production Use and Defaults" from the official Elasticsearch documentation.

> **Note:** The Elasticsearch Notes for Production Use also mentions disabling swapping for performance reasons. Depending on your Kubernetes installation or provider, swapping may already be disabled. To check this, `exec` into a running container and run `cat /proc/swaps` to list active swap devices. If you see nothing there, swap is disabled.

Now that we've defined our main app container and the Init Containers that run before it to tune the container OS, we can add the final piece to our StatefulSet object definition file: the `volumeClaimTemplates`.

Paste in the following `volumeClaimTemplate` block:

elasticsearch_statefulset.yaml

```
. . .
  volumeClaimTemplates:
  - metadata:
      name: data
      labels:
        app: elasticsearch
    spec:
```

```
      accessModes: [ "ReadWriteOnce" ]
      storageClassName: do-block-storage
      resources:
        requests:
          storage: 100Gi
```

In this block, we define the StatefulSet's `volumeClaimTemplates`. Kubernetes will use this to create PersistentVolumes for the Pods. In the block above, we name it `data` (which is the `name` we refer to in the `volumeMount`s defined previously), and give it the same `app: elasticsearch` label as our StatefulSet.

We then specify its access mode as `ReadWriteOnce`, which means that it can only be mounted as read-write by a single node. We define the storage class as `do-block-storage` in this guide since we use a DigitalOcean Kubernetes cluster for demonstration purposes. You should change this value depending on where you are running your Kubernetes cluster. To learn more, consult the [Persistent Volume] documentation.

Finally, we specify that we'd like each PersistentVolume to be 100GiB in size. You should adjust this value depending on your production needs.

The complete StatefulSet spec should look something like this:

elasticsearch_statefulset.yaml

```
apiVersion: apps/v1
kind: StatefulSet
metadata:
  name: es-cluster
  namespace: kube-logging
spec:
  serviceName: elasticsearch
  replicas: 3
  selector:
    matchLabels:
      app: elasticsearch
  template:
    metadata:
      labels:
        app: elasticsearch
    spec:
      containers:
      - name: elasticsearch
        image: docker.elastic.co/elasticsearch/elasticsearch:7.2.0
        resources:
            limits:
              cpu: 1000m
            requests:
              cpu: 100m
        ports:
        - containerPort: 9200
```

```
          name: rest
          protocol: TCP
        - containerPort: 9300
          name: inter-node
          protocol: TCP
        volumeMounts:
        - name: data
          mountPath: /usr/share/elasticsearch/data
        env:
          - name: cluster.name
            value: k8s-logs
          - name: node.name
            valueFrom:
              fieldRef:
                fieldPath: metadata.name
          - name: discovery.seed_hosts
            value: "es-cluster-0.elasticsearch,es-cluster-1.elasticsearch,es-c
          - name: cluster.initial_master_nodes
            value: "es-cluster-0,es-cluster-1,es-cluster-2"
          - name: ES_JAVA_OPTS
            value: "-Xms512m -Xmx512m"
      initContainers:
      - name: fix-permissions
        image: busybox
        command: ["sh", "-c", "chown -R 1000:1000 /usr/share/elasticsearch/dat
        securityContext:
          privileged: true
        volumeMounts:
        - name: data
          mountPath: /usr/share/elasticsearch/data
      - name: increase-vm-max-map
        image: busybox
        command: ["sysctl", "-w", "vm.max_map_count=262144"]
        securityContext:
          privileged: true
      - name: increase-fd-ulimit
        image: busybox
        command: ["sh", "-c", "ulimit -n 65536"]
        securityContext:
          privileged: true
  volumeClaimTemplates:
  - metadata:
      name: data
      labels:
        app: elasticsearch
    spec:
      accessModes: [ "ReadWriteOnce" ]
      storageClassName: do-block-storage
      resources:
        requests:
          storage: 100Gi
```

Once you're satisfied with your Elasticsearch configuration, save and close the file.

Now, deploy the StatefulSet using `kubectl`:

```
$ kubectl create -f elasticsearch_statefulset.yaml
```

Copy

You should see the following output:

```
Output
statefulset.apps/es-cluster created
```

You can monitor the StatefulSet as it is rolled out using `kubectl rollout status`:

```
$ kubectl rollout status sts/es-cluster --namespace=kube-logging
```

Copy

You should see the following output as the cluster is rolled out:

```
Output
Waiting for 3 pods to be ready...
Waiting for 2 pods to be ready...
Waiting for 1 pods to be ready...
partitioned roll out complete: 3 new pods have been updated...
```

Once all the Pods have been deployed, you can check that your Elasticsearch cluster is functioning correctly by performing a request against the REST API.

To do so, first forward the local port `9200` to the port `9200` on one of the Elasticsearch nodes (`es-cluster-0`) using `kubectl port-forward`:

```
$ kubectl port-forward es-cluster-0 9200:9200 --namespace=kube-logging
```

Copy

Then, in a separate terminal window, perform a `curl` request against the REST API:

```
$ curl http://localhost:9200/_cluster/state?pretty
```

Copy

You shoulds see the following output:

```
Output
{
  "cluster_name" : "k8s-logs",
  "compressed_size_in_bytes" : 348,
  "cluster_uuid" : "QD06dK7CQgids-GQZooNVw",
  "version" : 3,
```

```
    "state_uuid" : "mjNIWXAzQVuxNNOQ7xR-qg",
    "master_node" : "IdM5B7cUQWqFgIHXBp0JDg",
    "blocks" : { },
    "nodes" : {
      "u7DoTpMmSCixOoictzHItA" : {
        "name" : "es-cluster-1",
        "ephemeral_id" : "ZlBflnXKRMC4RvEACHIVdg",
        "transport_address" : "10.244.8.2:9300",
        "attributes" : { }
      },
      "IdM5B7cUQWqFgIHXBp0JDg" : {
        "name" : "es-cluster-0",
        "ephemeral_id" : "JTk1FDdFQuWbSFAtBxdxAQ",
        "transport_address" : "10.244.44.3:9300",
        "attributes" : { }
      },
      "R8E7xcSUSbGbgrhAdyAKmQ" : {
        "name" : "es-cluster-2",
        "ephemeral_id" : "9wv6ke71Qqy9vk2LgJTqaA",
        "transport_address" : "10.244.40.4:9300",
        "attributes" : { }
      }
    },
  ...
```

This indicates that our Elasticsearch cluster `k8s-logs` has successfully been created with 3 nodes: `es-cluster-0`, `es-cluster-1`, and `es-cluster-2`. The current master node is `es-cluster-0`.

Now that your Elasticsearch cluster is up and running, you can move on to setting up a Kibana frontend for it.

Step 3 — Creating the Kibana Deployment and Service

To launch Kibana on Kubernetes, we'll create a Service called `kibana`, and a Deployment consisting of one Pod replica. You can scale the number of replicas depending on your production needs, and optionally specify a `LoadBalancer` type for the Service to load balance requests across the Deployment pods.

This time, we'll create the Service and Deployment in the same file. Open up a file called `kibana.yaml` in your favorite editor:

```
$ nano kibana.yaml
```

Copy

Paste the following service spec:

kibana.yaml

```
apiVersion: v1
kind: Service
metadata:
  name: kibana
  namespace: kube-logging
  labels:
    app: kibana
spec:
  ports:
  - port: 5601
  selector:
    app: kibana
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: kibana
  namespace: kube-logging
  labels:
    app: kibana
spec:
  replicas: 1
  selector:
    matchLabels:
      app: kibana
  template:
    metadata:
      labels:
        app: kibana
    spec:
      containers:
      - name: kibana
        image: docker.elastic.co/kibana/kibana:7.2.0
        resources:
          limits:
            cpu: 1000m
          requests:
            cpu: 100m
        env:
          - name: ELASTICSEARCH_URL
            value: http://elasticsearch:9200
        ports:
        - containerPort: 5601
```

Then, save and close the file.

In this spec we've defined a service called `kibana` in the `kube-logging` namespace, and gave it the `app: kibana` label.

We've also specified that it should be accessible on port `5601` and use the `app: kibana` label to select the Service's target Pods.

In the `Deployment` spec, we define a Deployment called `kibana` and specify that we'd like 1 Pod replica.

We use the `docker.elastic.co/kibana/kibana:7.2.0` image. At this point you may substitute your own private or public Kibana image to use.

We specify that we'd like at the very least 0.1 vCPU guaranteed to the Pod, bursting up to a limit of 1 vCPU. You may change these parameters depending on your anticipated load and available resources.

Next, we use the `ELASTICSEARCH_URL` environment variable to set the endpoint and port for the Elasticsearch cluster. Using Kubernetes DNS, this endpoint corresponds to its Service name `elasticsearch`. This domain will resolve to a list of IP addresses for the 3 Elasticsearch Pods. To learn more about Kubernetes DNS, consult [DNS for Services and Pods](#).

Finally, we set Kibana's container port to `5601`, to which the `kibana` Service will forward requests.

Once you're satisfied with your Kibana configuration, you can roll out the Service and Deployment using `kubectl`:

```
$ kubectl create -f kibana.yaml
```
Copy

You should see the following output:

```
Output
service/kibana created
deployment.apps/kibana created
```

You can check that the rollout succeeded by running the following command:

```
$ kubectl rollout status deployment/kibana --namespace=kube-logging
```
Copy

You should see the following output:

```
Output
deployment "kibana" successfully rolled out
```

To access the Kibana interface, we'll once again forward a local port to the Kubernetes node running Kibana. Grab the Kibana Pod details using `kubectl get`:

```
$ kubectl get pods --namespace=kube-logging
```
Copy

```
Output
NAME                       READY     STATUS    RESTARTS   AGE
es-cluster-0               1/1       Running   0          55m
es-cluster-1               1/1       Running   0          54m
es-cluster-2               1/1       Running   0          54m
kibana-6c9fb4b5b7-plbg2    1/1       Running   0          4m27s
```

Here we observe that our Kibana Pod is called `kibana-6c9fb4b5b7-plbg2`.

Forward the local port `5601` to port `5601` on this Pod:

```
$ kubectl port-forward kibana-6c9fb4b5b7-plbg2 5601:5601 --namespace=
```

Copy

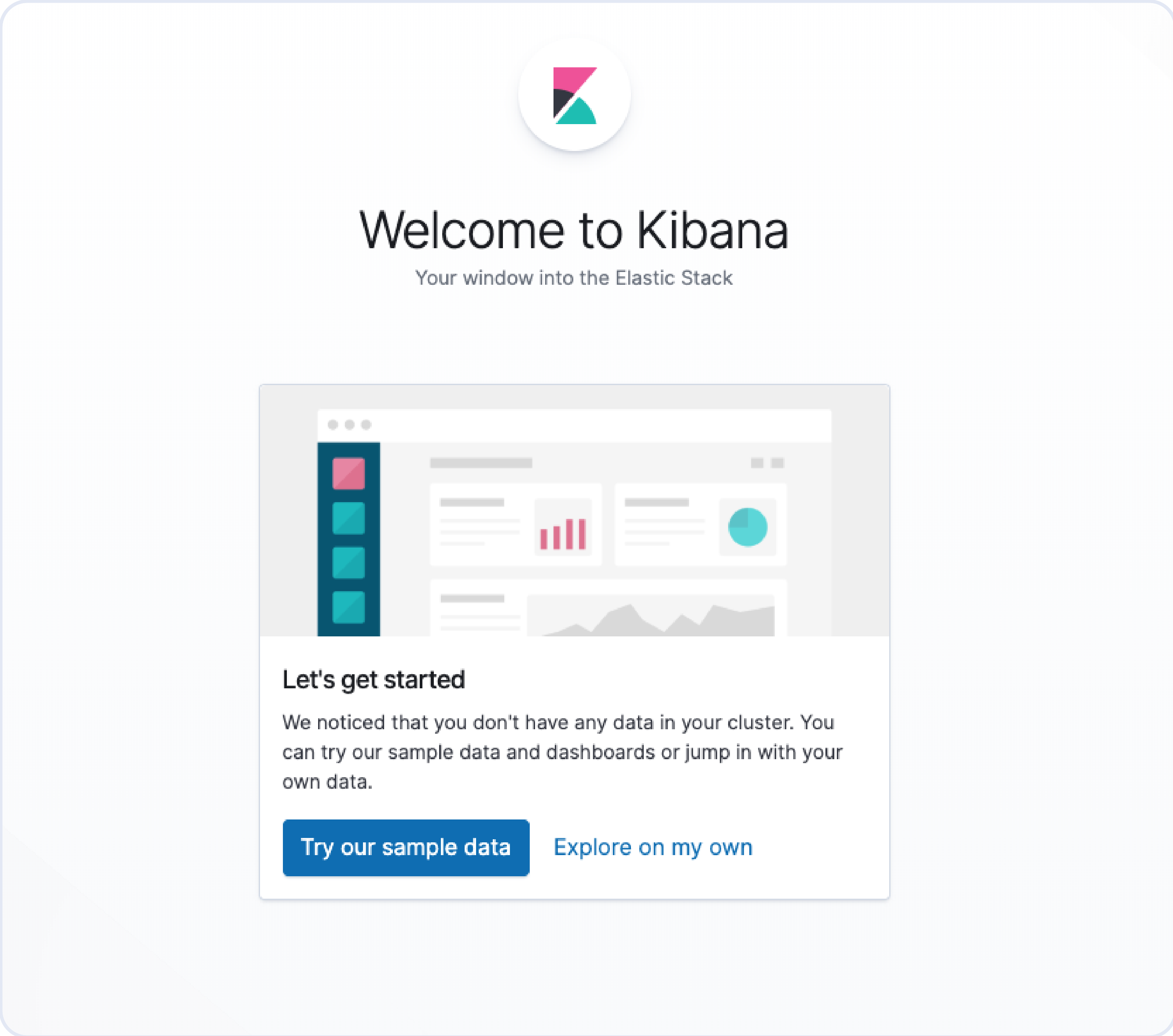
You should see the following output:

```
Output
Forwarding from 127.0.0.1:5601 -> 5601
Forwarding from [::1]:5601 -> 5601
```

Now, in your web browser, visit the following URL:

```
http://localhost:5601
```

If you see the following Kibana welcome page, you've successfully deployed Kibana into your Kubernetes cluster:



You can now move on to rolling out the final component of the EFK stack: the log collector, Fluentd.

Step 4 – Creating the Fluentd DaemonSet

In this guide, we'll set up Fluentd as a DaemonSet, which is a Kubernetes workload type that runs a copy of a given Pod on each Node in the Kubernetes cluster. Using this DaemonSet controller, we'll roll out a Fluentd logging agent Pod on every node in our cluster. To learn more about this logging architecture, consult "Using a node logging agent" from the official Kubernetes docs.

In Kubernetes, containerized applications that log to `stdout` and `stderr` have their log streams captured and redirected to JSON files on the nodes. The Fluentd Pod will tail these log files, filter log events, transform the log data, and ship it off to the Elasticsearch logging backend we deployed in Step 2.

In addition to container logs, the Fluentd agent will tail Kubernetes system component logs like kubelet, kube-proxy, and Docker logs. To see a full list of sources tailed by the Fluentd logging agent, consult the `kubernetes.conf` file used to configure the logging agent. To learn more about logging in Kubernetes clusters, consult "Logging at the node level" from the official Kubernetes documentation.

Begin by opening a file called `fluentd.yaml` in your favorite text editor:

```
$ nano fluentd.yaml
```

Copy

Once again, we'll paste in the Kubernetes object definitions block by block, providing context as we go along. In this guide, we use the Fluentd DaemonSet spec provided by the Fluentd maintainers. Another helpful resource provided by the Fluentd maintainers is Kuberentes Fluentd.

First, paste in the following ServiceAccount definition:

fluentd.yaml

```
apiVersion: v1
kind: ServiceAccount
metadata:
  name: fluentd
  namespace: kube-logging
  labels:
    app: fluentd
```

Here, we create a Service Account called `fluentd` that the Fluentd Pods will use to access the Kubernetes API. We create it in the `kube-logging` Namespace and once again give it the label `app: fluentd`. To learn more about Service Accounts in Kubernetes, consult Configure Service Accounts for Pods in the official Kubernetes docs.

Next, paste in the following `ClusterRole` block:

fluentd.yaml

```
. . .
---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: fluentd
  labels:
    app: fluentd
rules:
- apiGroups:
  - ""
```

```
  resources:
  - pods
  - namespaces
  verbs:
  - get
  - list
  - watch
```

Here we define a ClusterRole called `fluentd` to which we grant the `get`, `list`, and `watch` permissions on the `pods` and `namespaces` objects. ClusterRoles allow you to grant access to cluster-scoped Kubernetes resources like Nodes. To learn more about Role-Based Access Control and Cluster Roles, consult [Using RBAC Authorization]() from the official Kubernetes documentation.

Now, paste in the following `ClusterRoleBinding` block:

fluentd.yaml

```
. . .
---
kind: ClusterRoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: fluentd
roleRef:
  kind: ClusterRole
  name: fluentd
  apiGroup: rbac.authorization.k8s.io
subjects:
- kind: ServiceAccount
  name: fluentd
  namespace: kube-logging
```

In this block, we define a `ClusterRoleBinding` called `fluentd` which binds the `fluentd` ClusterRole to the `fluentd` Service Account. This grants the `fluentd` ServiceAccount the permissions listed in the `fluentd` Cluster Role.

At this point we can begin pasting in the actual DaemonSet spec:

fluentd.yaml

```
. . .
---
apiVersion: apps/v1
kind: DaemonSet
metadata:
  name: fluentd
  namespace: kube-logging
```

```
  labels:
    app: fluentd
```

Here, we define a DaemonSet called `fluentd` in the `kube-logging` Namespace and give it the `app: fluentd` label.

Next, paste in the following section:

fluentd.yaml

```
. . .
spec:
  selector:
    matchLabels:
      app: fluentd
  template:
    metadata:
      labels:
        app: fluentd
    spec:
      serviceAccount: fluentd
      serviceAccountName: fluentd
      tolerations:
      - key: node-role.kubernetes.io/master
        effect: NoSchedule
      containers:
      - name: fluentd
        image: fluent/fluentd-kubernetes-daemonset:v1.4.2-debian-elasticsearch
        env:
```


Here, we match the `app: fluentd` label defined in `.metadata.labels` and then assign the DaemonSet the `fluentd` Service Account. We also select the `app: fluentd` as the Pods managed by this DaemonSet.

Next, we define a `NoSchedule` toleration to match the equivalent taint on Kubernetes master nodes. This will ensure that the DaemonSet also gets rolled out to the Kubernetes masters. If you don't want to run a Fluentd Pod on your master nodes, remove this toleration. To learn more about Kubernetes taints and tolerations, consult "Taints and Tolerations" from the official Kubernetes docs.

Next, we begin defining the Pod container, which we call `fluentd`.

We use the [official v1.4.2 Debian image](#) provided by the Fluentd maintainers. If you'd like to use your own private or public Fluentd image, or use a different image version, modify the `image` tag in the container spec. The Dockerfile and contents of this image are available in Fluentd's [fluentd-kubernetes-daemonset Github repo](#).

Next, we configure Fluentd using some environment variables:

- `FLUENT_ELASTICSEARCH_HOST`: We set this to the Elasticsearch headless Service address defined earlier: `elasticsearch.kube-logging.svc.cluster.local`. This will resolve to a list of IP addresses for the 3 Elasticsearch Pods. The actual Elasticsearch host will most likely be the first IP address returned in this list. To distribute logs across the cluster, you will need to modify the configuration for Fluentd's Elasticsearch Output plugin. To learn more about this plugin, consult [Elasticsearch Output Plugin](#).
- `FLUENT_ELASTICSEARCH_PORT`: We set this to the Elasticsearch port we configured earlier, `9200`.
- `FLUENT_ELASTICSEARCH_SCHEME`: We set this to `http`.
- `FLUENTD_SYSTEMD_CONF`: We set this to `disable` to suppress output related to `systemd` not being set up in the container.

Finally, paste in the following section:

fluentd.yaml

```
. . .
        resources:
          limits:
            memory: 512Mi
          requests:
            cpu: 100m
            memory: 200Mi
        volumeMounts:
        - name: varlog
          mountPath: /var/log
        - name: varlibdockercontainers
          mountPath: /var/lib/docker/containers
          readOnly: true
      terminationGracePeriodSeconds: 30
      volumes:
      - name: varlog
        hostPath:
          path: /var/log
      - name: varlibdockercontainers
        hostPath:
          path: /var/lib/docker/containers
```

Here we specify a 512 MiB memory limit on the FluentD Pod, and guarantee it 0.1vCPU and 200MiB of memory. You can tune these resource limits and requests depending on your anticipated log volume and available resources.

Next, we mount the `/var/log` and `/var/lib/docker/containers` host paths into the container using the `varlog` and `varlibdockercontainers` `volumeMounts`. These `volumes` are defined at the end of the block.

The final parameter we define in this block is `terminationGracePeriodSeconds`, which gives Fluentd 30 seconds to shut down gracefully upon receiving a `SIGTERM` signal. After 30 seconds, the containers are sent a `SIGKILL` signal. The default value for `terminationGracePeriodSeconds` is 30s, so in most cases this parameter can be omitted. To learn more about gracefully terminating Kubernetes workloads, consult Google's "Kubernetes best practices: terminating with grace."

The entire Fluentd spec should look something like this:

fluentd.yaml

```
apiVersion: v1
kind: ServiceAccount
metadata:
  name: fluentd
  namespace: kube-logging
  labels:
    app: fluentd
---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: fluentd
  labels:
    app: fluentd
rules:
- apiGroups:
  - ""
  resources:
  - pods
  - namespaces
  verbs:
  - get
  - list
  - watch
---
kind: ClusterRoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: fluentd
roleRef:
  kind: ClusterRole
  name: fluentd
  apiGroup: rbac.authorization.k8s.io
subjects:
```

```
- kind: ServiceAccount
  name: fluentd
  namespace: kube-logging
---
apiVersion: apps/v1
kind: DaemonSet
metadata:
  name: fluentd
  namespace: kube-logging
  labels:
    app: fluentd
spec:
  selector:
    matchLabels:
      app: fluentd
  template:
    metadata:
      labels:
        app: fluentd
    spec:
      serviceAccount: fluentd
      serviceAccountName: fluentd
      tolerations:
      - key: node-role.kubernetes.io/master
        effect: NoSchedule
      containers:
      - name: fluentd
        image: fluent/fluentd-kubernetes-daemonset:v1.4.2-debian-elasticsearch
        env:
          - name:  FLUENT_ELASTICSEARCH_HOST
            value: "elasticsearch.kube-logging.svc.cluster.local"
          - name:  FLUENT_ELASTICSEARCH_PORT
            value: "9200"
          - name: FLUENT_ELASTICSEARCH_SCHEME
            value: "http"
          - name: FLUENTD_SYSTEMD_CONF
            value: disable
        resources:
          limits:
            memory: 512Mi
          requests:
            cpu: 100m
            memory: 200Mi
        volumeMounts:
        - name: varlog
          mountPath: /var/log
        - name: varlibdockercontainers
          mountPath: /var/lib/docker/containers
          readOnly: true
      terminationGracePeriodSeconds: 30
      volumes:
      - name: varlog
        hostPath:
```

```
          path: /var/log
      - name: varlibdockercontainers
        hostPath:
          path: /var/lib/docker/containers
```

Once you've finished configuring the Fluentd DaemonSet, save and close the file.

Now, roll out the DaemonSet using `kubectl`:

```
$ kubectl create -f fluentd.yaml
```

Copy

You should see the following output:

```
Output
serviceaccount/fluentd created
clusterrole.rbac.authorization.k8s.io/fluentd created
clusterrolebinding.rbac.authorization.k8s.io/fluentd created
daemonset.extensions/fluentd created
```

Verify that your DaemonSet rolled out successfully using `kubectl`:

```
$ kubectl get ds --namespace=kube-logging
```

Copy

You should see the following status output:

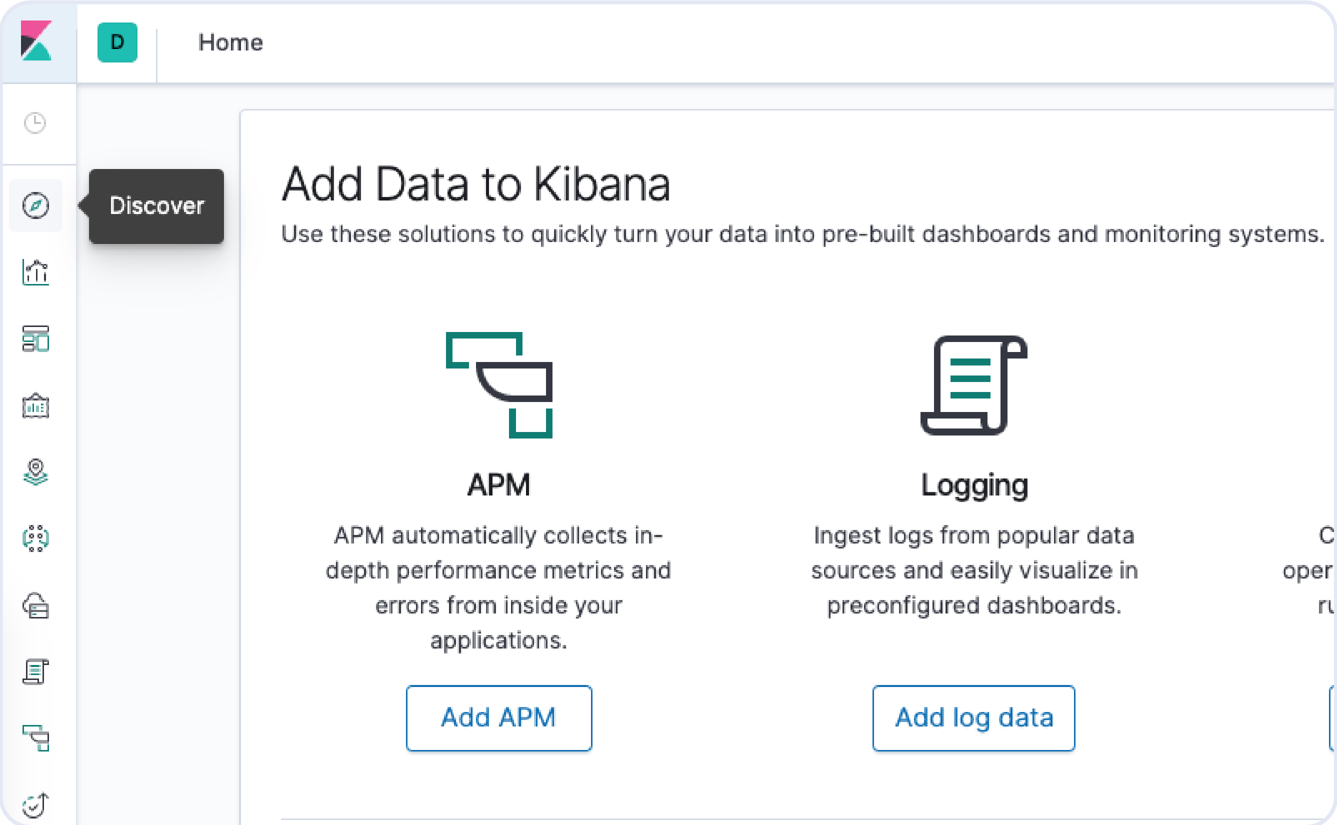
```
Output
NAME      DESIRED   CURRENT   READY     UP-TO-DATE   AVAILABLE   NODE SELECTOR
fluentd   3         3         3         3            3           <none>
```

This indicates that there are 3 `fluentd` Pods running, which corresponds to the number of nodes in our Kubernetes cluster.

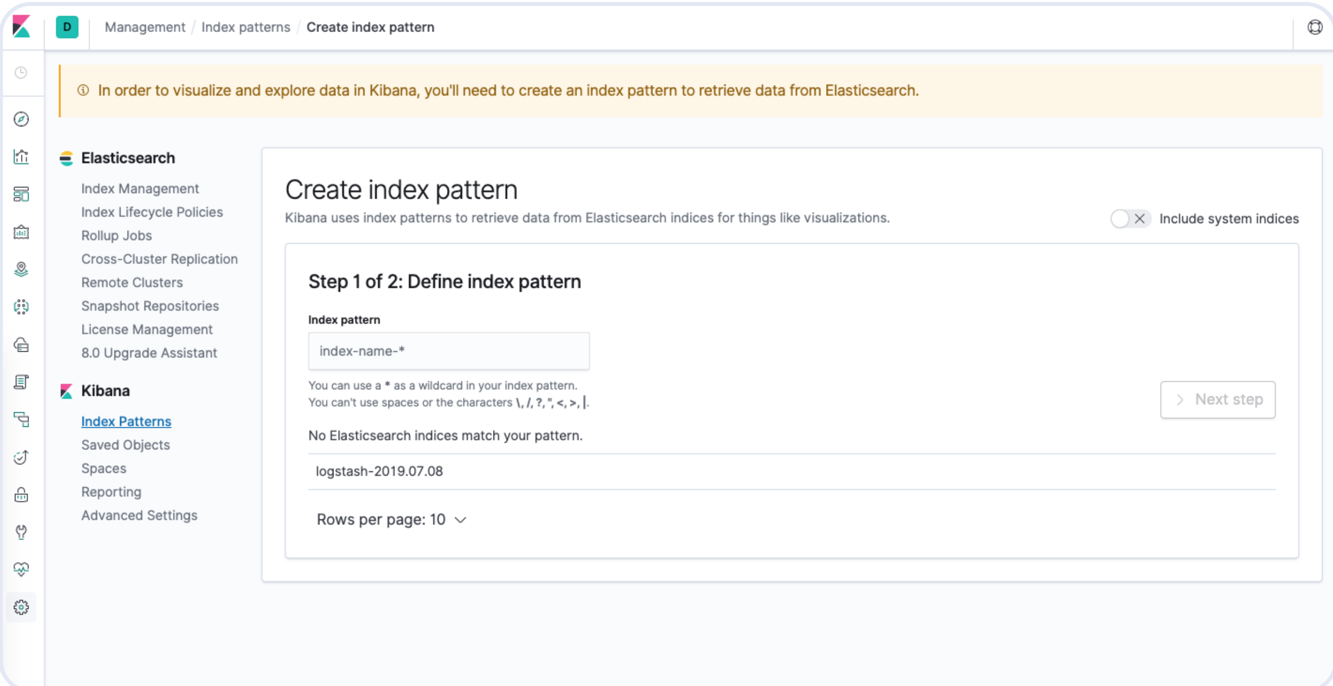
We can now check Kibana to verify that log data is being properly collected and shipped to Elasticsearch.

With the `kubectl port-forward` still open, navigate to `http://localhost:5601`.

Click on **Discover** in the left-hand navigation menu:

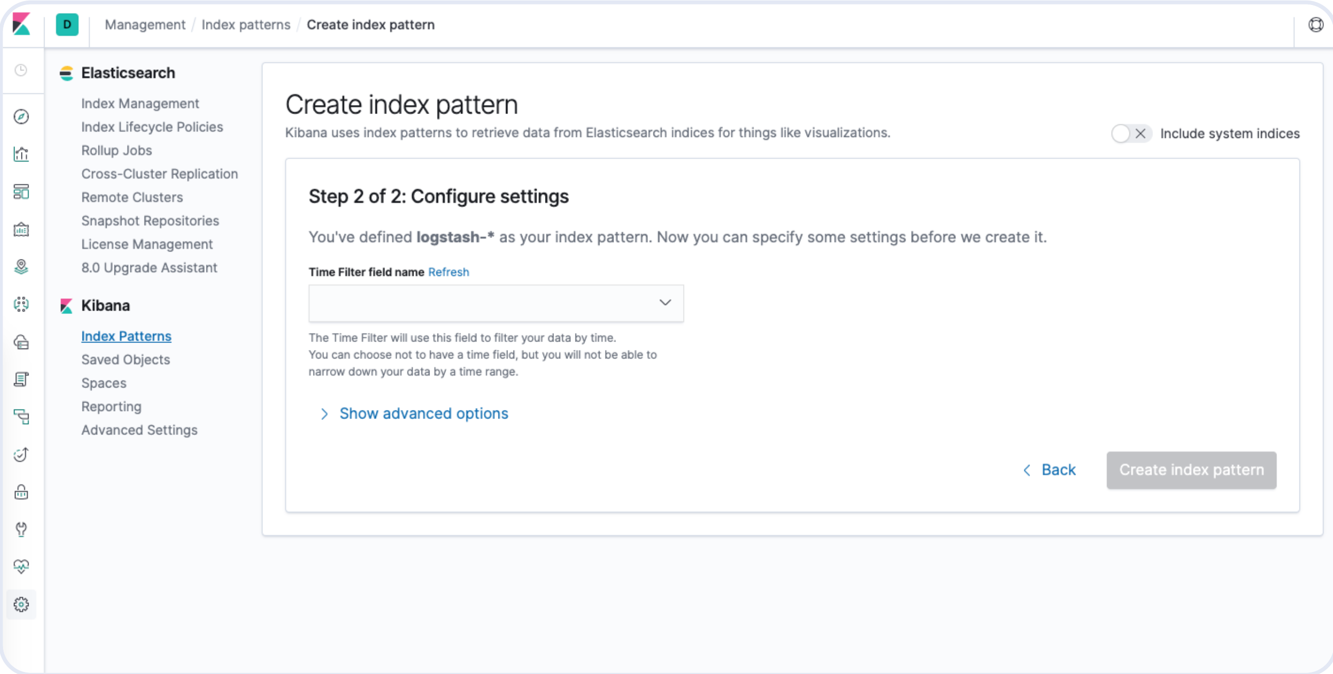


You should see the following configuration window:



This allows you to define the Elasticsearch indices you’d like to explore in Kibana. To learn more, consult [Defining your index patterns](#) in the official Kibana docs. For now, we’ll just use the `logstash-*` wildcard pattern to capture all the log data in our Elasticsearch cluster. Enter `logstash-*` in the text box and click on **Next step**.

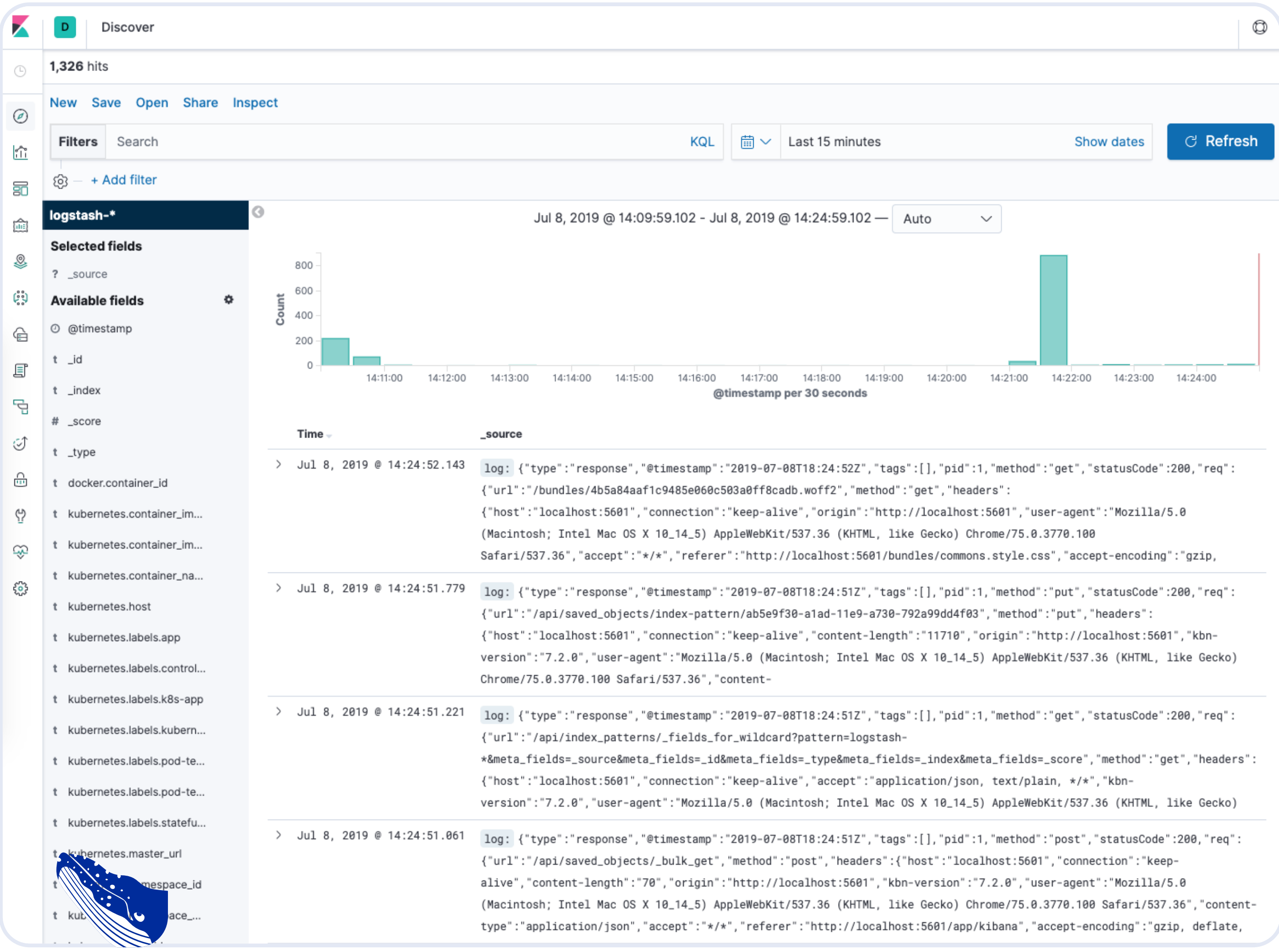
You’ll then be brought to the following page:



This allows you to configure which field Kibana will use to filter log data by time. In the dropdown, select the **@timestamp** field, and hit **Create index pattern**.

Now, hit **Discover** in the left hand navigation menu.

You should see a histogram graph and some recent log entries:



At this point you've successfully configured and rolled out the EFK stack on your Kubernetes cluster. To learn how to use Kibana to analyze your log data, consult the Kibana User Guide.

In the next optional section, we'll deploy a simple counter Pod that prints numbers to stdout, and find its logs in Kibana.

Step 5 (Optional) – Testing Container Logging

To demonstrate a basic Kibana use case of exploring the latest logs for a given Pod, we'll deploy a minimal counter Pod that prints sequential numbers to stdout.

Let's begin by creating the Pod. Open up a file called `counter.yaml` in your favorite editor:

```
$ nano counter.yaml
```

Copy

Then, paste in the following Pod spec:

counter.yaml

```
apiVersion: v1
kind: Pod
metadata:
  name: counter
spec:
  containers:
  - name: count
    image: busybox
    args: [/bin/sh, -c,
            'i=0; while true; do echo "$i: $(date)"; i=$((i+1)); sleep 1; done
```

Save and close the file.

This is a minimal Pod called `counter` that runs a `while` loop, printing numbers sequentially.

Deploy the `counter` Pod using `kubectl`:

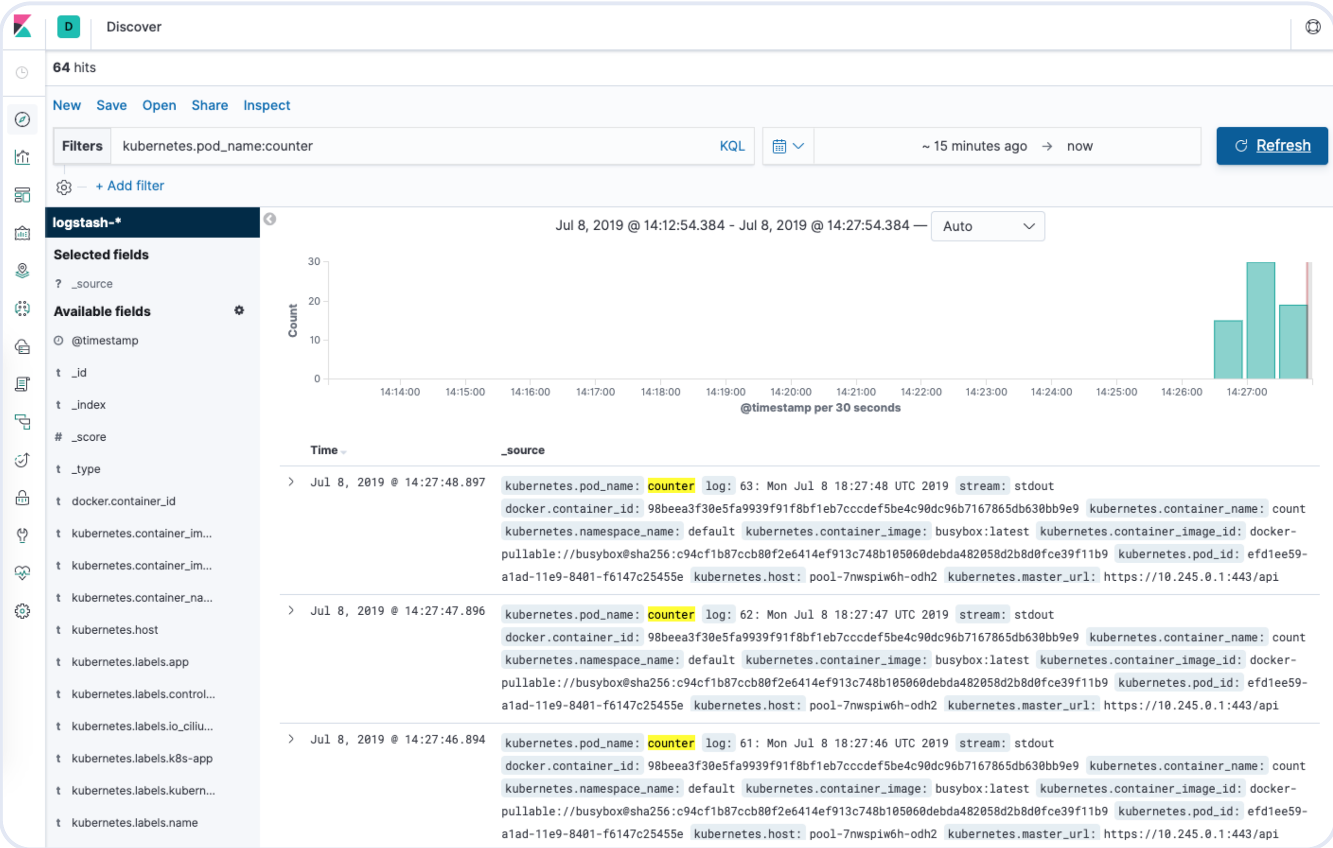
```
$ kubectl create -f counter.yaml
```

Copy

Once the Pod has been created and is running, navigate back to your Kibana dashboard.

From the **Discover** page, in the search bar enter `kubernetes.pod_name:counter`. This filters the log data for Pods named `counter`.

You should then see a list of log entries for the `counter` Pod:



You can click into any of the log entries to see additional metadata like the container name, Kubernetes node, Namespace, and more.

Conclusion

In this guide we've demonstrated how to set up and configure Elasticsearch, Fluentd, and Kibana on a Kubernetes cluster. We've used a minimal logging architecture that consists of a single logging agent Pod running on each Kubernetes worker node.

Before deploying this logging stack into your production Kubernetes cluster, it's best to tune the resource requirements and limits as indicated throughout this guide. You may also want to set up X-Pack to enable built-in monitoring and security features.

The logging architecture we've used here consists of 3 Elasticsearch Pods, a single Kibana Pod (not load-balanced), and a set of Fluentd Pods rolled out as a DaemonSet. You may wish to scale this setup depending on your production use case. To learn more about scaling your Elasticsearch and Kibana stack, consult Scaling Elasticsearch.

Kubernetes also allows for more complex logging agent architectures that may better suit your use case. To learn more, consult Logging Architecture from the Kubernetes docs.

About the authors

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ciaran4d51781530ee70807025 • December 4, 2018

However, I'm having an issue on Digital Ocean's Kubernetes Service, I've tried on a new cluster, v1.12.3 and each time the elastic search stateful set fails due to issues with pvc's,

e.g. Warning FailedScheduling 16m default-scheduler pod has unbound immediate PersistentVolumeClaims

Show replies Reply

stalinbritto • July 12, 2019

Hi Team, I have followed and when I execute elasticsearch_statefulset.yaml, am getting below output and it's taking a long time. It couldn't step forward further.

root@hostname:~/kube# kubectl rollout status sts/es-cluster --namespace kube-logging Waiting for 3 pods to be ready...

Show replies Reply

roisgs2 • July 6, 2020

I was able to deploy es-cluster-[0-2] successfully but every couple of minutes one of them crashes, after seeing in the logs:

```
{"type": "server", "timestamp": "2020-07-06T13:31:39,744+0000", "level
```

its like a loop that one crashes because it cant resolve the others, and than the others crashes because they cant resolve him

Show replies Reply

kristiyangostev • June 23, 2020

For everyone with: "Output: Waiting for 3 pods to be ready…"

AND

"pod has unbound immediate PersistentVolumeClaims"

Check what storage classes you have in your cluster with "kubectl get storageclass" Then replace the "storageClassName" accordingly. This worked for me and the pods started successfully. Now lets if the will work properly as well… :D

Show replies Reply

Jean Andrew Fuentes • June 25, 2019

Hi great details on the tutorial, however I'm still getting an error.

plugin:elasticsearch@6.4.3 Service Unavailable

at the kibana part it says status red too. and upon check of the pods of elastic this is the error.

```
fatal error on the network layer
        at org.elasticsearch.transport.netty4.Netty4Utils.maybeDie(Net
        at org.elasticsearch.transport.netty4.Netty4MessageChannelHanc
        at io.netty.channel.AbstractChannelHandlerContext.invokeExcept
        at io.netty.channel.AbstractChannelHandlerContext.invokeExcept
```

Also this is the logs when I tried to proxy and curl elastic search

```
kubectl port-forward es-cluster-0 9200:9200 --namespace=kube-logging
Forwarding from 127.0.0.1:9200 -> 9200
Forwarding from [::1]:9200 -> 9200
Handling connection for 9200
E0625 10:11:26.617570    7659 portforward.go:400] an error occurred fc
```

Reply

poojajagdale18 • March 14, 2019

curl http://localhost:9200/_cluster/state?pretty gives me output as: "error" : { "root_cause" : [{ "type" : "master_not_discovered_exception", "reason" : null }], "type" : "master_not_discovered_exception", "reason" : null }, "status" : 503

Show replies Reply

BuddyCasino • February 28, 2019

This is the only detailed, correct and up-to-date tutorial on setting up a K8S Elasticsearch cluster on whole internet. Thanks!

Reply

kiran4d51781530ee70807025 • December 4, 2018

Very detailed and helpful tutorial thanks.

Reply

khizarshujaat • January 9, 2023

Hi, First of all thanks for great tutorial. I'm trying to setup basic_auth with the elasticsearch 7, but getting error `master_not_discovered_exception`. Can you help me to sort out this issue?

Reply

b56be15376814986921e98e54ef64 • November 25, 2022

Hi All,

I am requesting help since I am stuck in the end part of Step 4. I completed the setup up to the deployment of Fluentd Deamonsets.

But when I try to create index pattern in Kibana (first I tried without system indices). There is no place to add 'logstash-*' and I cannot proceed to next step.

Then I tried including system indices. Then 'logstash-*' was not recognized as an index pattern.

Does anyone face this issue? Can someone help me to make this success? Thank you.

Reply

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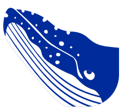

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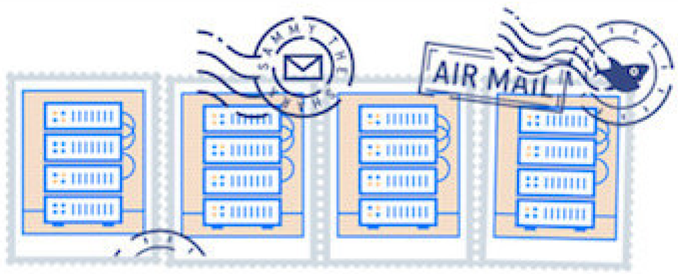

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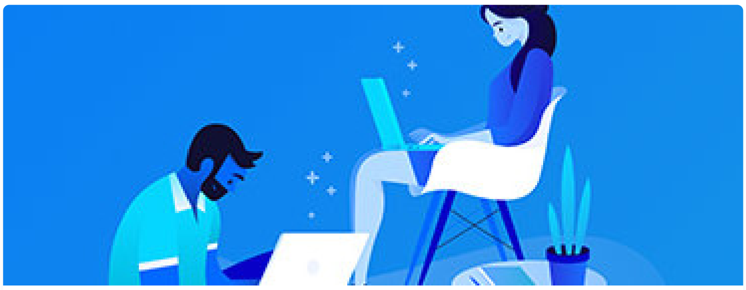

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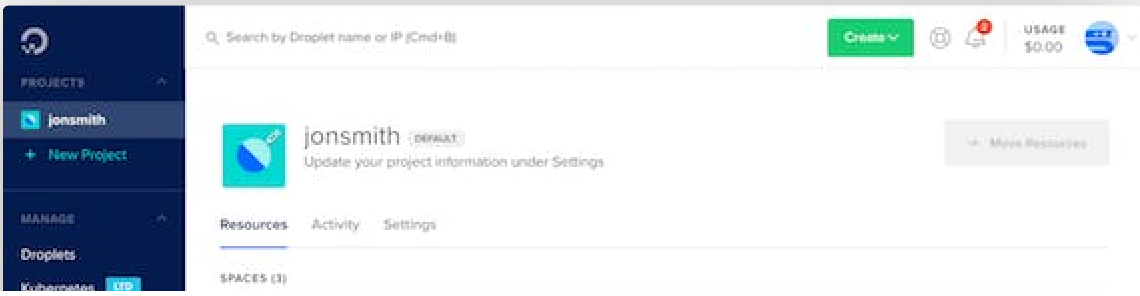

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