

## OX PowerDNS Cloud Control

### **Overview**

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# Contents

<b>1</b>	<b>Cloud Control</b>	<b>1</b>
1.1	Simple deployment	1
1.2	Complex deployment	2
1.3	Rules & Actions	2
<b>2</b>	<b>Cloud Control on Kubernetes</b>	<b>3</b>
2.1	DNSdist	3
2.1.1	DNSdist agent	4
2.2	Recursor	5
2.3	Resolver	6
2.4	Ruleset	6
<b>3</b>	<b>Getting Started</b>	<b>7</b>
3.1	Install Tools	7
3.2	Download Helm Chart	7
3.3	Download Helm Chart (OCI - experimental)	8
3.4	Helm Chart configuration	8
3.4.1	Registry Credentials	8
3.4.2	Deploying Recursor	9
3.4.3	Adding DNSdist	10
3.4.4	Adding an external Resolver	11
3.4.5	Adding a DNSdist rule	12
3.4.6	Using DNSdist rules to route traffic	13
3.4.7	Separating config into multiple files	15
<b>4</b>	<b>Troubleshooting</b>	<b>17</b>
4.1	Accessing DNSdist console	17
4.2	Pod Events	18

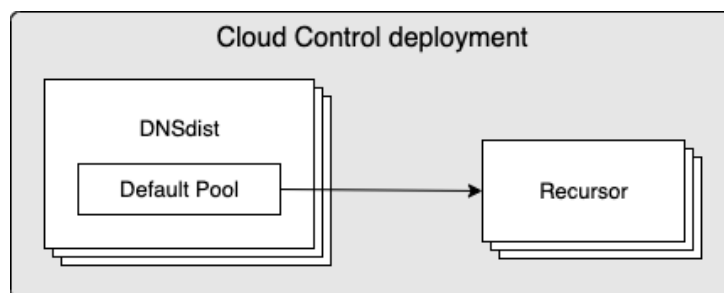
# 1 Cloud Control

Cloud Control facilitates orchestration, management & monitoring of OX PowerDNS products in Kubernetes deployments. OX PowerDNS products supported in this version are:

- OX PowerDNS DNSdist - A DNS, DoS and abuse-aware loadbalancer that brings out the best possible performance in any DNS deployment.
- OX PowerDNS Recursor - A high-performing, low latency DNS resolver

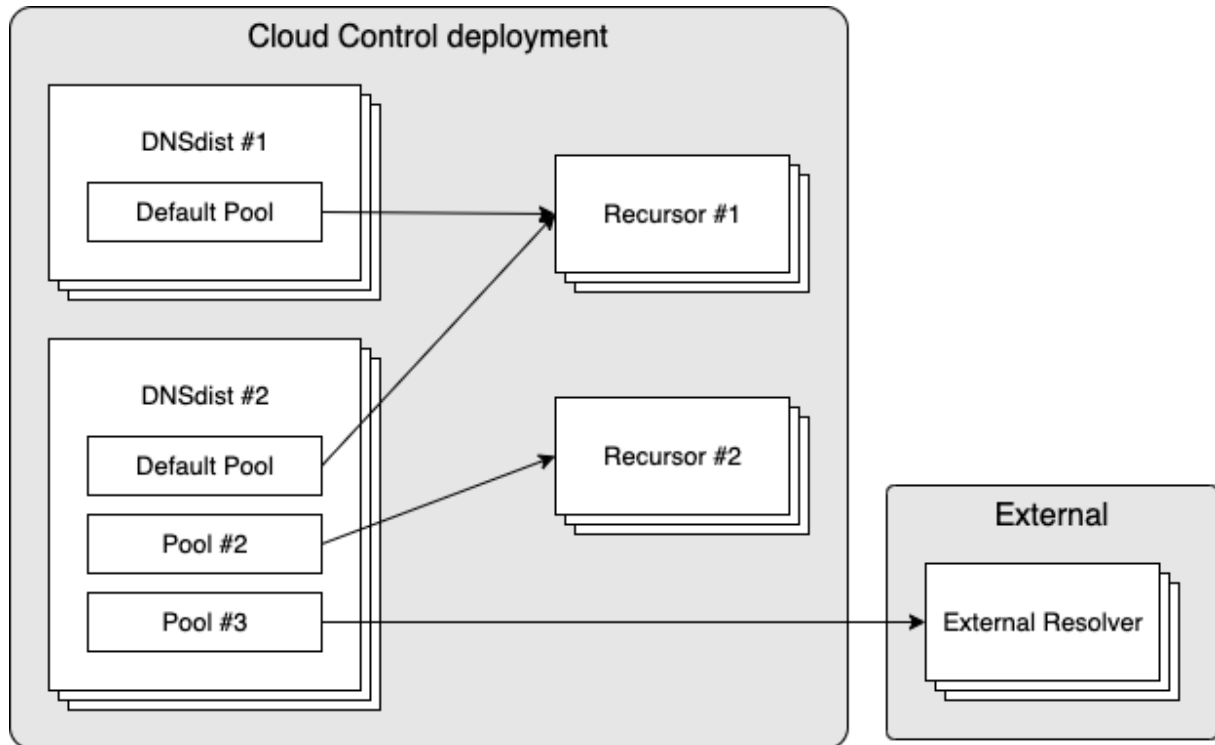
## 1.1 Simple deployment

In its most simple deployment scenario, Cloud Control can be used to roll out a set of Recursor instances, with a set of DNSdists in front. In the below diagram you can see a set of DNSdist instances, with a default pool sending all traffic to a set of Recursor instances:



## 1.2 Complex deployment

In a more complex deployment you can deploy multiple sets of DNSdist & Recursor instances, with DNSdist using multiple pools to send traffic to the different Recursors. In addition, DNSdist can be configured to send traffic to DNS resolvers which are not part of the Cloud Control deployment.



## 1.3 Rules & Actions

Deciding which traffic to send to each pool is handled by DNSdist's packet policies, which offers a mechanism to define rules and corresponding actions. In the context of the above diagram, such rules & actions could be:

Rule	Action
'Source' of request in '130.161.0.0/16'	'let pool #2 handle the request'
'Qname' of request matches a regex	'let pool #3 handle the request'
'Qtype' of request is 'ANY'	'send response with REFUSED'

---

**Note:** By default, all requests will be handled by the 'Default Pool'

---

## 2 Cloud Control on Kubernetes

Cloud Control provides a Helm Chart which allows for the definition & configuration of the following:

- **dnsdist** - Definition of a set of OX PowerDNS DNSdist instances and corresponding configuration
- **recursor** - Definition of a set of OX PowerDNS Recursor instances and corresponding configuration
- **resolver** - Definition of a set of external resolver endpoints
- **ruleset** - Definition of a set of rules which can be applied to DNSdist instances

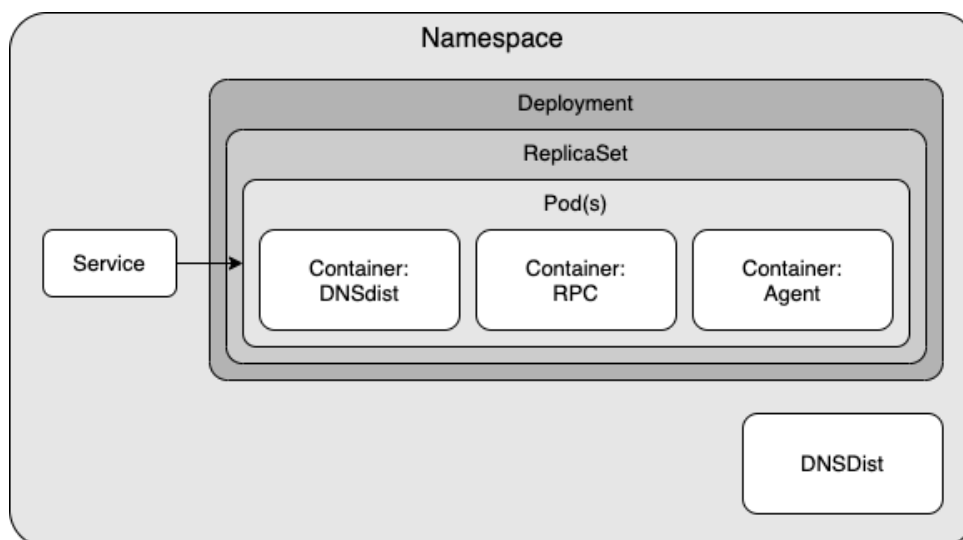
The following sections discuss each in more detail.

### 2.1 DNSdist

For each dnsdist defined in the input to the Helm Chart, objects of the following types (kind in Kubernetes) will be created in Kubernetes:

Kind	API Group	Description
DNSDist	cloudcontrol. powerdns.com	Object which holds configuration of the DNSdist instances
Deployment	core	Deployment of DNSdist pods (including ReplicaSet)
Service	core	Service which can be used to direct traffic to the DNSdist pods

When a dnsdist instance is configured using the Helm Chart, it will deploy the following to Kubernetes:



As the diagram shows a DNSdist pod will consist of 3 containers:

- **DNSdist** - Runs DNSdist and is responsible for handling the actual inbound DNS queries.
- **RPC** - Runs an API that is responsible for handling JSON messages over HTTP from the agent and forwarding them to dnsdist as RPC. Future versions of Cloud Control will see the need for this container removed to allow for direct communication between the agent & DNSdist.
- **Agent** - Contains an agent that watches several kinds of objects in Kubernetes within the namespace. If any watched objects are created/updated/removed, the agent will sync any corresponding configuration items to the running dnsdist instance. The agent is described in detail in the next chapter.

### 2.1.1 DNSdist agent

The DNSdist agent is responsible for keeping the configuration of the running DNSdist process in sync with the desired configuration. If any configuration changes are needed, the agent will attempt to synchronize them without restarting the DNSdist process. These configuration changes range from performance parameters defined in the DNSDist object to adjusting server pools according to changes observed in Recursor deployments.

Items which are watched by the agent are:

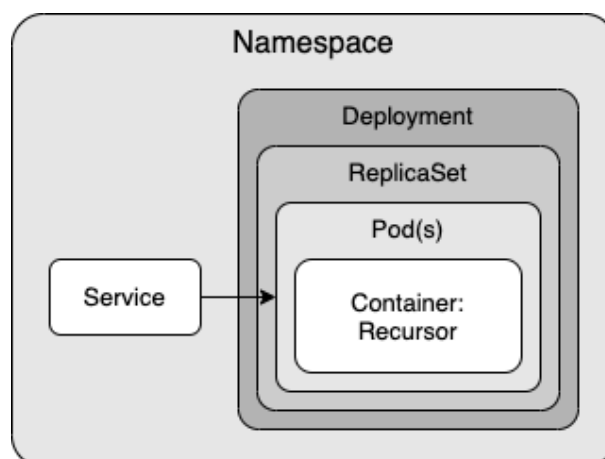
Kind	Purpose
DNSDist	The object which contains the configuration details for a DNSdist deployment. If any updates are detected the agent will attempt to update the configuration of DNSdist without having to restart it.
Pod	The agent watches the pod which it is a part of. Particularly the statuses of each container inside the pod are observed, to ensure the agent can synchronize a DNSdist instance again if it's container was recycled for any reason.
DNSDistRule	Any rule objects which match the RuleSelector on the DNSDist object are watched and synchronized to the DNSdist process if needed. Any new rules that match the RuleSelector are also applied as soon as they are observed by the agent.
Service & Endpoints	The agent watches for changes in the Endpoints of any Service objects which match the ServiceSelector of the DNSDist object. This allows the agent to discover the servers that should be part of the pool(s) in DNSdist and works for both Recursor & resolver deployments.

## 2.2 Recursor

For each recursor defined in the input to the Helm Chart, objects of the following types (aka kind in Kubernetes terminology) will be created in Kubernetes:

Kind	API Group	Description
Deployment	core	Deployment of Recursor pods (including ReplicaSet)
Service	core	Service which can be discovered by DNSdist agents to direct traffic to the Recursor pods

When a recursor instance is configured using the Helm Chart, it will deploy the following to Kubernetes:

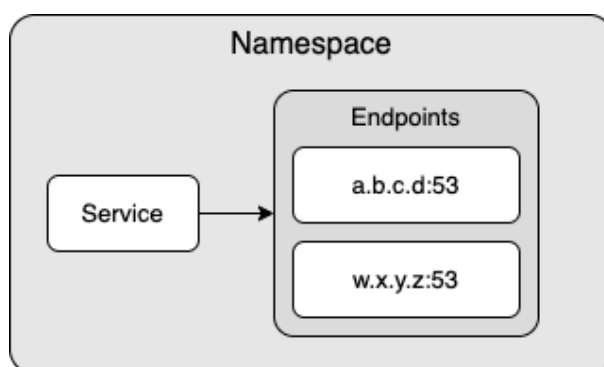


## 2.3 Resolver

For each resolver defined in the input to the Helm Chart, objects of the following types (aka kind in Kubernetes terminology) will be created in Kubernetes:

Kind	API Group	Description
Endpoints	core	Object that holds each IP:port combination defined for the resolver
Service	core	Service which can be discovered by DNSdist agents to direct traffic to the resolver's endpoints

When a resolver instance is configured using the Helm Chart, it will deploy the following to Kubernetes:



## 2.4 Ruleset

For each ruleset defined in the input to the Helm Chart, objects of the following types (aka kind in Kubernetes terminology) will be created in Kubernetes:

Kind	API Group	Description
DNSDistRule	cloudcontrol. powerdns.com	Object which holds configuration of a set of rules which can be discovered by DNSdist agents and applied to DNSdist without restarting



## 3 Getting Started

### 3.1 Install Tools

You will need the following software on the machine from which you want to deploy Cloud Control:

- Kubectl (Configured for your target Kubernetes cluster)
- Helm v3 (<https://helm.sh/docs/intro/install/>)

### 3.2 Download Helm Chart

Cloud Control Helm Charts are available on the Open-Xchange registry, located at: [registry.open-xchange.com](https://registry.open-xchange.com).

There are several methods for obtaining Helm Charts using Helm's CLI, in this chapter we are using a method that copies the chart locally to your filesystem prior to using it. Any Helm-supported method will work, but you will need to adjust the commands in this guide accordingly if you wish to utilise a different method.

First step will be to make Helm aware of the Cloud Control repository (replace username & password with your OX registry credentials):

```
helm repo add cloudcontrol https://registry.open-xchange.com/chartrepo/cloudcontrol \
--username=REGISTRY_USERNAME_HERE --password=REGISTRY_PASSWORD_HERE
```

Once the repository has been added you can pull the Cloud Control Helm Charts. To pull the powerdns Helm Chart and export it to your current working directory use the following commands:

```
# The release we're working with
CCTAG=1.0.0

# Ensure repo data is up-to-date
helm repo update

# Pull the Helm Chart & unpack
helm pull cloudcontrol/powerdns -d . --version=$CCTAG --untar
```

### 3.3 Download Helm Chart (OCI - experimental)

Helm v3 includes OCI support, although it is still experimental and expected to contain breaking changes prior to official release. Cloud Control is made available in OCI format, but recommended deployment methodology remains the traditional way of working with Helm Charts.

To work with Helm's OCI capabilities, you need to enable Helm OCI support using:

```
export HELM_EXPERIMENTAL_OCI=1
```

Cloud Control Helm Charts are available on the Open-Xchange registry, located at: [registry.open-xchange.com](https://registry.open-xchange.com). To make sure Helm can interact with the registry, use the Helm registry login command:

```
helm registry login registry.open-xchange.com
```

Once authenticated you can pull & export the Cloud Control Helm Charts. To pull the powerdns Helm Chart and export it to your current working directory use the following commands:

```
# The release we're working with
CCTAG=1.0.0

# Pull the Helm Chart from the registry
helm chart pull registry.open-xchange.com/cloudcontrol/helm-cc-powerdns:$CCTAG

# Export the Helm Chart to the current working directory
helm chart export registry.open-xchange.com/cloudcontrol/helm-cc-powerdns:$CCTAG -d .
```

### 3.4 Helm Chart configuration

The Cloud Control Helm Charts have a large amount of configurable options, which are detailed in the reference documentation. In the next few chapters the most important parts are discussed.

#### 3.4.1 Registry Credentials

Since the Cloud Control images are in a protected repository there is a requirement to configure credentials in the Helm Chart input YAML file. These need to be configured with the following block:

```
registrySecrets:
  registry: registry.open-xchange.com
  username: REGISTRY_USERNAME_HERE
  password: REGISTRY_PASSWORD_HERE
  email: admin@registry.open-xchange.com
```

Make sure the username & password match your credentials for the OX registry.

### 3.4.2 Deploying Recursor

To deploy a set of Recursor instances, include an entry in the YAML file under the 'recursors' parent, such as:

```
recursors:
  myrecursor:
    replicas: 3
registrySecrets:
  registry: registry.open-xchange.com
  username: REGISTRY_USERNAME_HERE
  password: REGISTRY_PASSWORD_HERE
  email: admin@registry.open-xchange.com
```

The above file will create a set of Recursor instances named 'myrecursor' and the Deployment in Kubernetes will have a ReplicaSet with replicas=3. If you save this file as 'values.yaml' in your current working directory you should be able to use the Helm Chart to create the Recursor instances:

```
# The namespace
CC_NAMESPACE=my-namespace
HELM_RELEASE=ccdemo

helm install $HELM_RELEASE ./powerdns --namespace $CC_NAMESPACE --create-namespace \
--values ./values.yaml
```

**Note:** you can remove --create-namespace if you have an existing namespace to deploy into

Using kubectl you should now be able to see the corresponding Kubernetes objects created:

```
# Kubectl command to show all objects in a namespace
kubectl get all --namespace=my-namespace

# Kubectl output
```

NAME	READY	STATUS	RESTARTS	AGE
pod/myrecursor-589559675d-d57jk	1/1	Running	0	3m12s
pod/myrecursor-589559675d-m779s	1/1	Running	0	3m12s
pod/myrecursor-589559675d-xxrvc	1/1	Running	0	3m12s

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
service/recursor-myrecursor	ClusterIP	None	<none>	5353/TCP	3m12s

NAME	READY	UP-TO-DATE	AVAILABLE	AGE
deployment.apps/myrecursor	3/3	3	3	3m12s

NAME	DESIRED	CURRENT	READY	AGE
replicaset.apps/myrecursor-589559675d	3	3	3	3m12

Result should be a deployment + replicaset + service + a number of pods equal to the 'replicas' value from the values.yaml file.

### 3.4.3 Adding DNSdist

To add a set of DNSdist instances to our deployment, include an entry in the YAML file under the 'dnsdists' parent, such as:

```
dnsdists:
  mydnsdist:
    replicas: 2
    pools:
      default:
        serverGroups:
          - myrecursor
recursors:
  myrecursor:
    replicas: 3
registrySecrets:
  registry: registry.open-xchange.com
  username: REGISTRY_USERNAME_HERE
  password: REGISTRY_PASSWORD_HERE
  email: admin@registry.open-xchange.com
```

The above will add a set of DNSdist instances named 'mydnsdist' and the Deployment in Kubernetes will have a ReplicaSet with replicas=2. The 'pools' configuration instructs DNSdist's agent to make sure all instances of 'myrecursor' are added to the default pool in DNSdist.

Save the values.yaml file and upgrade the environment using the Helm Chart:

```
# The namespace
CC_NAMESPACE=my-namespace

# Helm release name
HELM_RELEASE=ccdemo

helm upgrade $HELM_RELEASE ./powerdns --namespace $CC_NAMESPACE --values=./values.yaml
```

Using kubectl you should now be able to see the corresponding Kubernetes objects created for DNSdist:

```
# Kubectl command to show all objects in a namespace
kubectl get all --namespace=my-namespace

# Kubectl output
```

NAME	READY	STATUS	RESTARTS	AGE
pod/mydnsdist-775cbf55d9-qjtk5	3/3	Running	1	15m
pod/mydnsdist-775cbf55d9-t8fbk	3/3	Running	1	15m
pod/myrecursor-589559675d-d57jk	1/1	Running	0	27m
pod/myrecursor-589559675d-m779s	1/1	Running	0	27m
pod/myrecursor-589559675d-xrvvc	1/1	Running	0	27m

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
service/recursor-myrecursor	ClusterIP	None	<none>	5353/TCP	27m

NAME	READY	UP-TO-DATE	AVAILABLE	AGE
deployment.apps/mydnsdist	2/2	2	2	15m
deployment.apps/myrecursor	3/3	3	3	27m

NAME	DESIRED	CURRENT	READY	AGE
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replicaset.apps/mydnsdist-775cbf55d9	2	2	2	15m
replicaset.apps/myrecursor-589559675d	3	3	3	27m

### 3.4.4 Adding an external Resolver

To add a set of external resolvers to our deployment, include an entry in the YAML file under the 'resolvers' parent, such as:

```
dnsdists:
  mydnsdist:
    replicas: 2
    pools:
      default:
        serverGroups:
          - myrecursor
          - myresolver
recursors:
  myrecursor:
    replicas: 3
resolvers:
  myresolver:
    ips:
      - 9.9.9.9
      - 149.112.112.112
registrySecrets:
  registry: registry.open-xchange.com
  username: REGISTRY_USERNAME_HERE
  password: REGISTRY_PASSWORD_HERE
  email: admin@registry.open-xchange.com
```

The above will add a Service named 'myresolver' in Kubernetes which will have an Endpoints object containing the IP addresses (in this example the Quad9 IPs). By adding 'myresolver' to the 'default' pool in DNSdist, traffic will be loadbalanced between the Recursor & resolver endpoints (not a realistic scenario, which will be tackled in the next chapter).

Save the values.yaml file and upgrade the environment using the Helm Chart:

```
# The namespace
CC_NAMESPACE=my-namespace

# Helm release name
HELM_RELEASE=ccdemo

helm upgrade $HELM_RELEASE ./powerdns --namespace $CC_NAMESPACE --values=./values.yaml
```

Using kubectl you should now be able to see the corresponding Kubernetes objects created for resolver (the service object named 'myresolver'):

```
# Kubectl command to show all objects in a namespace
kubectl get all --namespace=my-namespace

# Kubectl output
NAME                                READY   STATUS    RESTARTS   AGE
pod/mydnsdist-775cbf55d9-qwvrq     3/3     Running   0           22s
```

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pod/mydnsdist-775cbf55d9-szw2w	3/3	Running	0	22s	
pod/myrecursor-589559675d-5sqmg	1/1	Running	0	22s	
pod/myrecursor-589559675d-cv6bl	1/1	Running	0	22s	
pod/myrecursor-589559675d-sptfh	1/1	Running	0	22s	
NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
service/recursor-myrecursor	ClusterIP	None	<none>	5353/TCP	22s
service/resolver-myresolver	ClusterIP	None	<none>	53/TCP	22s
NAME	READY	UP-TO-DATE	AVAILABLE	AGE	
deployment.apps/mydnsdist	2/2	2	2	22s	
deployment.apps/myrecursor	3/3	3	3	22s	
NAME	DESIRED	CURRENT	READY	AGE	
replicaset.apps/mydnsdist-775cbf55d9	2	2	2	22s	
replicaset.apps/myrecursor-589559675d	3	3	3	22s	

### 3.4.5 Adding a DNSdist rule

To add more logic to DNSdist instances you can create rules under the 'rulesets' parent and assigning them to DNSdist objects, such as:

```

dnsdists:
  mydnsdist:
    replicas: 2
    pools:
      default:
        serverGroups:
          - myrecursor
          - myresolver
    rulegroups:
      - traffic-filters
recursors:
  myrecursor:
    replicas: 3
resolvers:
  myresolver:
    ips:
      - 9.9.9.9
      - 149.112.112.112
rulesets:
  block-traffic-ruleset:
    group: traffic-filters
    type: DNSDistRule
    priority: 100
    rules:
      - name: Block ANY
        combinator: AND
        selectors:
          - QType: ANY
        action:
          RCode:
            rcode: "REFUSED"
registrySecrets:

```

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```

registry: registry.open-xchange.com
username: REGISTRY_USERNAME_HERE
password: REGISTRY_PASSWORD_HERE
email: admin@registry.open-xchange.com

```

The above will add a DNSDistRule object named 'block-traffic-ruleset' in Kubernetes. This rule will select incoming queries with QType='ANY' and send a response 'REFUSED'. This rule is tagged with 'group' = 'traffic-filters', which is also added to the 'mydnsdist' rulegroups list, associating this rule to the DNSdist instances. More details on the specification of rules can be found in the reference guide.

Save the values.yaml file and upgrade the environment using the Helm Chart:

```

# The namespace
CC_NAMESPACE=my-namespace

# Helm release name
HELM_RELEASE=ccdemo

helm upgrade $HELM_RELEASE ./powerdns --namespace $CC_NAMESPACE --values=./values.yaml

```

Using kubectl you should now be able to see the corresponding Kubernetes objects if you specifically request them (since kubectl will not show any custom object types with 'get all'):

```

# Kubectl command to show all DNSDistRule objects in a namespace
kubectl get dnsdistrule --namespace=my-namespace

# Kubectl output
NAME                AGE
block-traffic-ruleset 6s

```

### 3.4.6 Using DNSdist rules to route traffic

In a previous step we added recursors & resolvers to the default pool, but it would make more sense to have them in separate pools so they can serve different purposes. Rules allow this behaviour to be configured, such as:

```

dnsdists:
  mydnsdist:
    replicas: 2
    pools:
      default:
        serverGroups:
          - myrecursor
      external:
        serverGroups:
          - myresolver
    rulegroups:
      - traffic-filters
      - traffic-routers
  recursors:
    myrecursor:
      replicas: 3

```

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```

resolvers:
  myresolver:
    ips:
      - 9.9.9.9
      - 149.112.112.112
rulesets:
  route-traffic-ruleset:
    group: traffic-routers
    type: DNSDistRule
    priority: 200
    rules:
      - name: External IPv6 resolution
        combinator: AND
        selectors:
          - QType: AAAA
        action:
          Pool:
            poolname: "external"
  block-traffic-ruleset:
    group: traffic-filters
    type: DNSDistRule
    priority: 100
    rules:
      - name: Block ANY
        combinator: AND
        selectors:
          - QType: ANY
        action:
          RCode:
            rcode: "REFUSED"
registrySecrets:
  registry: registry.open-xchange.com
  username: REGISTRY_USERNAME_HERE
  password: REGISTRY_PASSWORD_HERE
  email: admin@registry.open-xchange.com

```

In the above example we moved the 'myresolver' group to a new pool named 'external'. Also, a new ruleset 'route-traffic-ruleset' was added which will match any queries with 'QType' = 'AAAA' and assign the pool named 'external' to handle those queries.

Save the values.yaml file and upgrade the environment using the Helm Chart:

```

# The namespace
CC_NAMESPACE=my-namespace

# Helm release name
HELM_RELEASE=cctesto

helm upgrade $HELM_RELEASE ./powerdns --namespace $CC_NAMESPACE --values=./values.yaml

```

Using kubectl you should now be able to see the new Kubernetes objects if you specifically request them (since kubectl will not show any custom object types with 'get all'):

```

# Kubectl command to show all DNSDistRule objects in a namespace
kubectl get dnsdistrule --namespace=my-namespace

```

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```
# Kubectl output
NAME          AGE
block-traffic-ruleset  33m
route-traffic-ruleset  2s
```

### 3.4.7 Separating config into multiple files

As you start adding more instances & configuration options to the Helm Chart input file it becomes harder to make sense of the config. A recommended approach to improving this is to make use of Helm's ability to add multiple values files to the arguments of the helm command line. For example:

registry.yaml:

```
registrySecrets:
  registry: registry.open-xchange.com
  username: REGISTRY_USERNAME_HERE
  password: REGISTRY_PASSWORD_HERE
  email: admin@registry.open-xchange.com
```

rulesets.yaml:

```
rulesets:
  block-traffic-ruleset:
    group: traffic-filters
    type: DNSDistRule
    priority: 100
    rules:
      - name: Block ANY
        combinator: AND
        selectors:
          - QType: ANY
        action:
          RCode:
            rcode: "REFUSED"
```

instances.yaml:

```
dnsdists:
  mydnsdist:
    replicas: 2
    pools:
      default:
        serverGroups:
          - myrecursor
        rulegroups:
          - traffic-filters
recursors:
  myrecursor:
    replicas: 3
```

You can then run helm as follows:

```
# The namespace
CC_NAMESPACE=my-namespace

# Helm release name
HELM_RELEASE=ccdemo

helm upgrade $HELM_RELEASE ./powerdns --namespace $CC_NAMESPACE \
--values=./registry.yaml --values=./rulesets.yaml --values=./instances.yaml
```

## 4 Troubleshooting

### 4.1 Accessing DNSdist console

DNSdist offers a commandline console which allows for debugging of issues and retrieving statistics. In Cloud Control deployments this is enabled by default and can be accessed via kubectl's exec command. This chapter will show how to gain access to the console and a few sample commands. For full documentation on the DNSdist console you can refer to: [DNSdist reference guide](#)

**Note:** While DNSdist's console exposes methods to modify a running instance we highly encourage users NOT to do this. Any change made to a running instance using the console will not persist and will not be synchronized to other DNSdist instances.

The following command can be used to gain access to the console:

```
# Pod name (make sure to replace with an existing DNSdist pod's name)
POD=mydnsdist-775cbf55d9-qjtk

# The namespace
CC_NAMESPACE=my-namespace

# Kubectl command to access the DNSdist console
kubectl exec -it $POD --namespace=$CC_NAMESPACE -c dnsdist -- dnsdist -c \
--config=/config/dnsdist.conf
```

You should then be presented with a console session as follows:

```
* dnsdist-state loaded
* Control socket set to 127.0.0.1:5199 with provided key
>
```

To see the status of the recursor and/or resolver instances that DNSdist will send queries to use showServers():

```
> showServers()
#   Name                               Address                State  Qps  Ord Wt  Queries  Pools
0   Endpoints/my-namespa 10.244.1.7:5353        up     0.0  1  1      546
1   Endpoints/my-namespa 10.244.1.8:5353        up     0.0  1  1         0
2   Endpoints/my-namespa 10.244.1.9:5353        up     0.0  1  1         0
3   Endpoints/my-namespa 149.112.112.112:53     up     0.0  1  1         0  external
4   Endpoints/my-namespa 9.9.9.9:53             up     0.0  1  1         0  external
All                                     0.0                                     546
```

Show the pools using showPools():

```
> showPools()
Name          Cache      ServerPolicy      Servers
external      leastOutstanding  leastOutstanding  10.244.1.7:5353, 10.244.1.8:5353, 10.244.1.9:5353
external      leastOutstanding  leastOutstanding  149.112.112.112:53, 9.9.9.9:53
```

List all rules with showRules():

```
> showRules()
#   Name      Matches      Rule              Action
0   Name      0             qtype==ANY       set rcode 5
1   Name      0             qtype==AAAA      to pool external
```

## 4.2 Pod Events

Cloud Control pods, primarily DNSdist, emit events to indicate potential problematic behaviour and provide tracability into the synchronisation processes.

There are many ways to list events in a namespace, for a pod, etc.. In the below example we'll use kubectl's get event to show the events for a specific pod, but in a production setting we recommend capturing these in your logging/monitoring infrastructure.

```
# Pod name (make sure to replace with an existing DNSdist pod's name)
POD=mydnsdist-775cbf55d9-qjtk

# The namespace
CC_NAMESPACE=my-namespace

# Kubectl command to list recent events emitted by a pod in a given namespace
kubectl get event --namespace=$CC_NAMESPACE --field-selector involvedObject.name=$POD
```

Examples of events generated by DNSdist pods (reformatted to fit):

```
# Event emitted by agent when a rule is updated
Type: Normal
Reason: DNSDistRuleUpdated
Object: pod/mydnsdist-775cbf55d9-gvjwk
Message: DNSDistRule 'my-namespace/block-traffic-ruleset' has been synchronised

# Event emitted by agent when a recursor/resolver endpoint changes
Type: Normal
Reason: EndpointsUpdated
Object: pod/mydnsdist-775cbf55d9-gvjwk
Message: Endpoints 'my-namespace/recursor-myrecursor' has been synchronised

# Event emitted by Kubernetes when a readiness probe fails
Type: Warning
Reason: Unhealthy
Object: pod/mydnsdist-775cbf55d9-gvjwk
Message: Readiness probe failed: HTTP probe failed with statuscode: 500
```