



OPEN SOURCE SUMMIT

NORTH AMERICA

THE LINUX FOUNDATION





Our Experiences deploying Kubernetes with IPv6

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Software Engineer
Covalent IO

What to expect from this talk?

- Quick history of IPv6
- IPv6 in kubernetes
 - Can I run it?
- Step by step tutorial + Demo

20 Years of IPv6

The year of IPv6?
December 2018

IPv6 history

IPv4 is not enough?

IETF - ROAD
November 1991

IPv6 was (re)born

RFC 2460
December 1998

No more IPv4 available!

Let's do NAT over NAT over NAT!
>2008

IPng was born

RFC 1883
December 1995

IPv6 in Linux 2.1.8

(Alpha)
~1996

IPv6 in Linux 2.6.12

(Stable)
~2005

IPv6 - Standard 86!

RFC 8200
July 2017

Containers!

Let's do IPv4, what could go wrong?
2014

A Kubernetes cluster on IPv6

- Is it really worth it?
 - Infrastructure?
 - Kubernetes itself
 - Does it run?
 - Pods, Services and Ingress?
 - Does my app / service work?
-

Is there any benefit to using IPv6 on my home network?

 I know that IPv6 is the future because there is only 4 billion IPv4 address, but on a home network, you are not going to have 4 billion users. So are there any other benefits that would make IPv6 on a home network better than using IPv4?
65

 [networking](#) [tcpip](#) [ipv6](#) [ipv4](#)

 share improve this question

4

edited Jun 10 '10 at 19:27

community wiki

2 revs, 2 users 100%

Macha

 18 But with IPv4 you can't give all of your kitchen appliances billions of IP addresses! – [Phoshi](#) Oct 19 '09 at 15:36

 8 'cause my fridge has a twitter habit and gets very very upset if it can't tweet to all the neighbor fridges... – [quack quixote](#) Dec 13 '09 at 22:07

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No, there is not any benefit to using IPv6 at home.

18

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Here is a relevant question: [What interesting uses for IPv6 are out there?](#)

[share](#) [improve this answer](#)

edited Mar 20 at 10:17

community wiki
2 revs
Troggy

2 Not true for all systems. Windows 7 Homegroups uses it (as mentioned in the link). – [jdh](#) Jan 5 '13 at 15:12

[add a comment](#)

Is there any benefit to using IPv6 on my home network?

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add a comment

57

Yes, there is a benefit to using IPv6 at home. The main one is education, i.e. you will gain experience at administering an IPv6 network that you can put on your resume. In about two years from now, sometime in 2011, the world will run out of IPv4 addresses and there will be a surge in demand for IPv6 networking, and that includes a demand for people experienced in administering IPv6.

share improve this answer

answered Oct 19 '09 at 15:33

community wiki
Michael Dillon

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networking to share improve

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Your house is not a datacenter*

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Pets vs Cattle (again...)

Your house has pets



- Frog - 192.168.0.1/24
- Turtle - 192.168.0.2/24
- Scared Rabbit - 192.168.0.3/24
- Happy Dog - 192.168.0.4/24
- Apathetic Cat - 192.168.0.5/24
- Serious hamster - 192.168.0.6/24
- Hypnotoad - 192.168.0.7/24

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- Hypnotoad - 192.168.0.7/24

Your datacenter has cattle



- Cows - 10.0.0.0/8
 - Black cows - 10.1.0.0/16
 - Brown cows - 10.2.0.0/16
 - White cows - 10.3.0.0/16
- Sheeps - 172.16.0.0/12
 - Excited Sheeps - 172.16.0.0/16
 - Sleepy Sheeps - 172.17.0.0/16

Pets vs Cattle (again...)

Your house has pets



- Frog - 192.168.0.1/24
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- Hypnotoad - 192.168.0.7/24

Your datacenter has cattle containers



- Containers - 10.0.0.0/8
 - Yellow - 10.1.0.0/16
 - Orange - 10.2.0.0/16
 - Red - 10.3.0.0/16
 - Bordeaux - 10.4.0.0/16

Pets vs Cattle (again...)

Your house has pets



Your datacenter has cattle lots of containers



- Frog - 192.168.0.1/24
- Turtle - 192.168.0.2/24
- Scared Rabbit - 192.168.0.3/24
- Happy Dog - 192.168.0.4/24
- Apathetic Cat - 192.168.0.5/24
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 - Red - 10.3.0.0/16
 - Bordeaux - 10.4.0.0/16
 - Yellow 2 - 10.5.0.0/16

Pets vs Cattle (again...)

Your house has pets



- Serious hamster - 192.168.0.6/24
- Hypnotoad - 192.168.0.7/24

Your datacenter has cattle lots of more containers



- Containers - 10.0.0.0/8
 - Yellow - 10.1.0.0/16
 - Orange - 10.2.0.0/16
 - Red - 10.3.0.0/16
 - Bordeaux - 10.4.0.0/16
 - Yellow 2 - 10.5.0.0/16
 - Orange 2 - 10.6.0.0/16
 - Blue 16 - 10.20.0.0/16

Pets vs Cattle (again...)

Your house has pets



- Serious hamster - 192.168.0.6/24
- Hypnotoad - 192.168.0.7/24

Your datacenter has cattle lots of more and more containers



- Containers - 10.0.0.0/8
 - Yellow - 10.1.0.0/16
 - Orange - 10.2.0.0/16
 - Red - 10.3.0.0/16
 - Bordeaux - 10.4.0.0/16
 - Yellow 2 - 10.5.0.0/16
 - Orange 2 - 10.6.0.0/16
 - Blue 16 - 10.20.0.0/16

ErrNoIPv4

Please help

Pets vs Cattle (again...)

Your house has pets



- Serious hamster - 192.168.0.6/24
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Your datacenter has cattle lots of more and more containers



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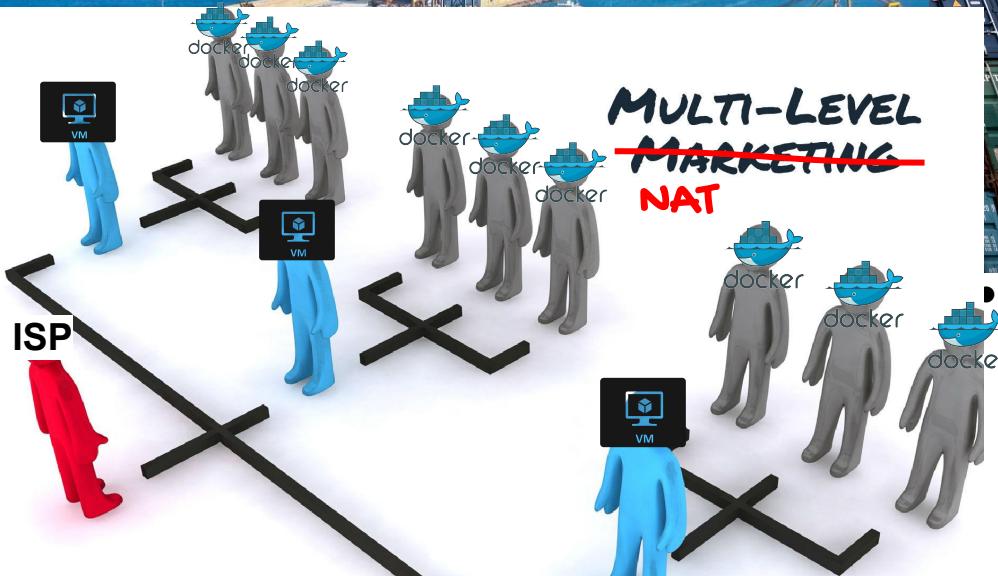
ErrNoIPv4

Please help

Pets vs Cattle (again...)

Your house has pets

No more IPv4s?! Let's do NAT!



Your datacenter has cattle lots of more and more containers



Containers - 10.0.0.0/8

- Yellow - 10.1.0.0/16
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ErrNoIPv4

Please help

Let's assemble our cluster

On premises

Cloud

1. Does my OS support IPv6?...

Let's assemble our cluster

On premises

1. Does my OS support IPv6?...
 2. Do my servers support IPv6?...
1. Does my OS support IPv6?...
 2. Do cloud providers support IPv6?
 - o AWS
 - o GCE

Cloud

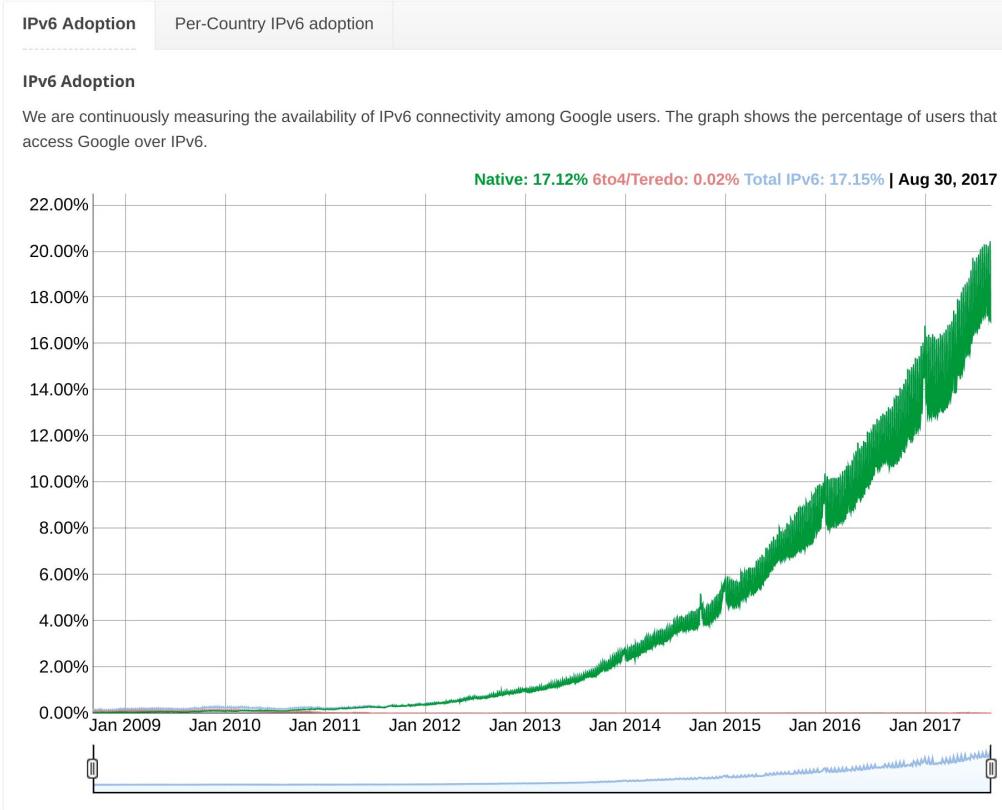
Let's assemble our cluster

On premises

Cloud

1. Does my OS support IPv6?...
2. Do my servers support IPv6?...
 2. Do cloud providers support IPv6?
 - AWS
 - GCE
 3. Can and will my users use IPv6?

Let's assemble our cluster



Cloud

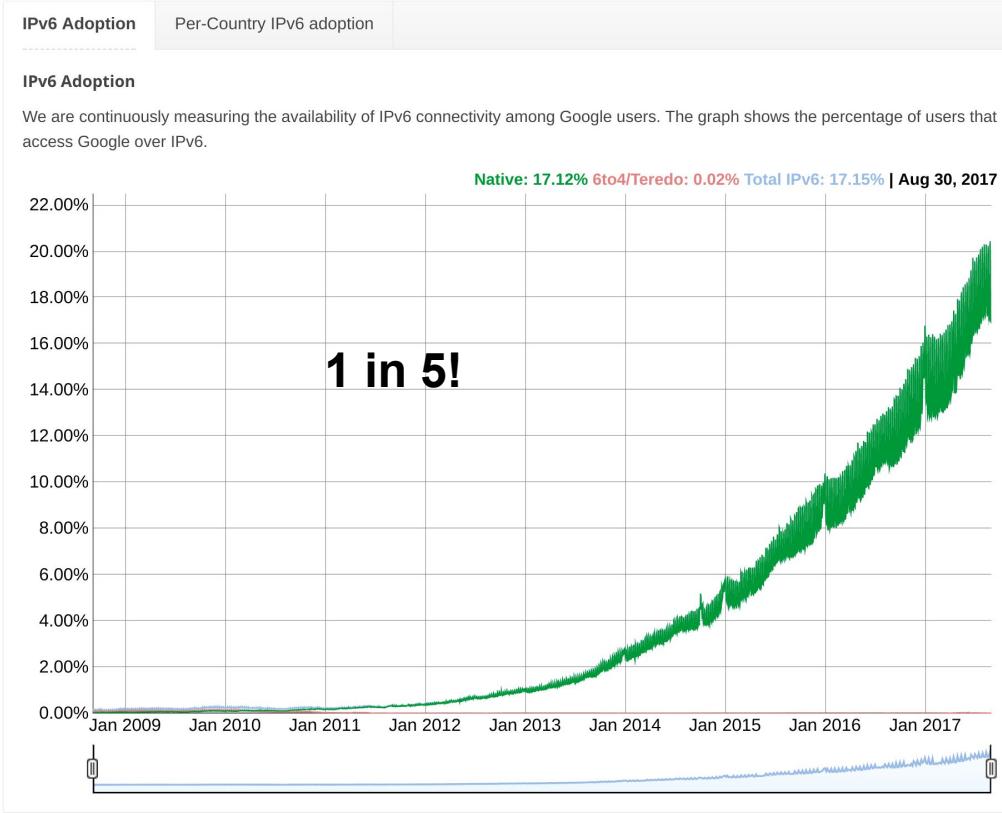
rt IPv6?...

› cloud providers support IPv6?

- AWS
- GCE

↳ use IPv6?

Let's assemble our cluster



Cloud

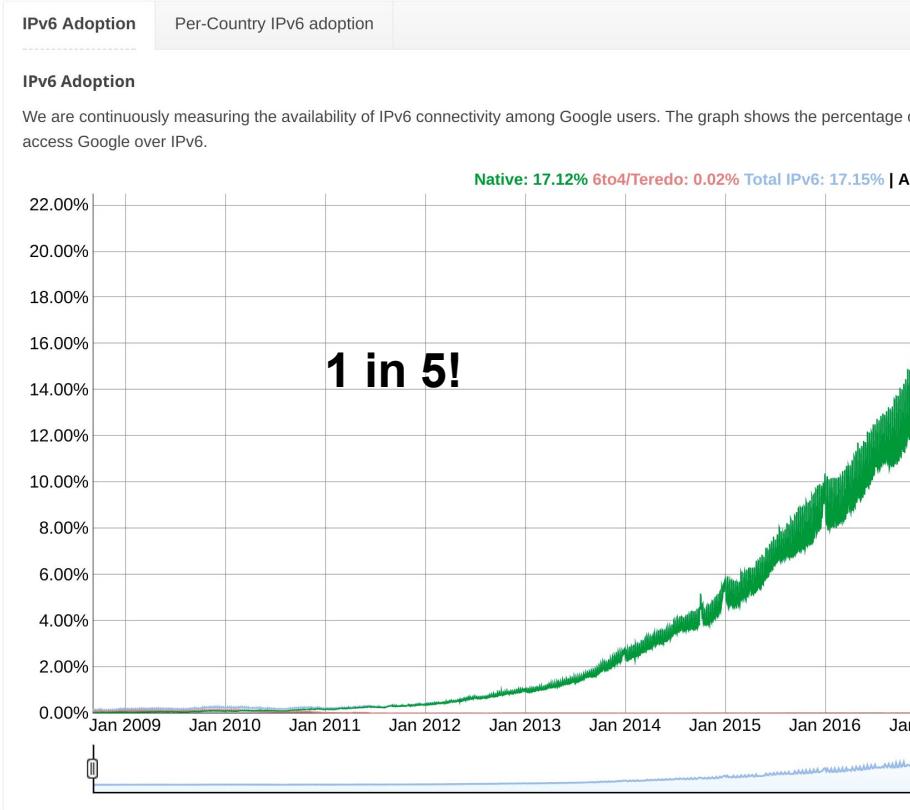
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↳ use IPv6?

Let's assemble our cluster



State of the Internet IPv6 Adoption Visualization

RANK	IPV6 %	COUNTRY
1	46.4%	Belgium
2	40.4%	United States of America
3	36.6%	India
4	32.2%	Greece
5	25.5%	Germany
6	21.7%	Luxembourg
7	20.8%	Switzerland



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Is it really worth it?

Infrastructure

Kubernetes - Does it run?

Kubernetes cheat sheet



controller-manager
kube-apiserver
kube-scheduler



master

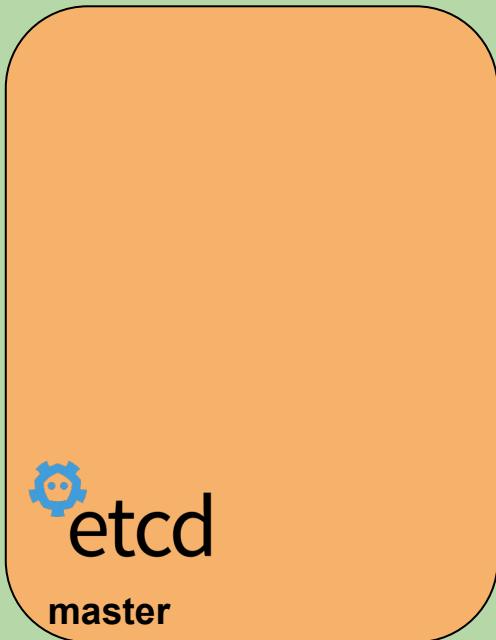


kubelet
kube-proxy
(cni plugin)



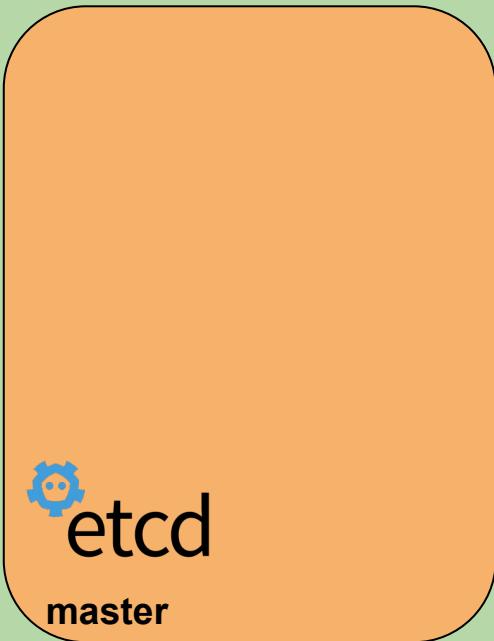
worker

1 - etcd



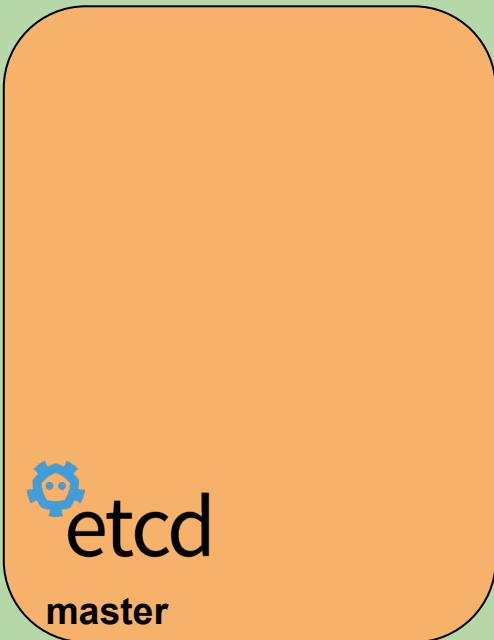
- 53 CLI options (etcd not etcdctl)

1 - etcd



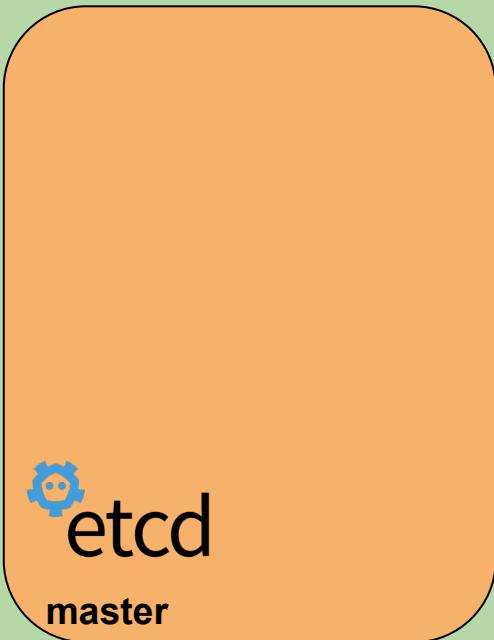
- 53 CLI options (etcd not etcdctl)
 - 5 relevant for IPv6
 - --advertise-client-urls '<http://localhost:2379>'
 - --initial-advertise-peer-urls '<http://localhost:2380>'
 - --initial-cluster 'default='<http://localhost:2380>'
 - --listen-client-urls '<http://localhost:2379>'
 - --listen-peer-urls '<http://localhost:2380>'

1 - etcd



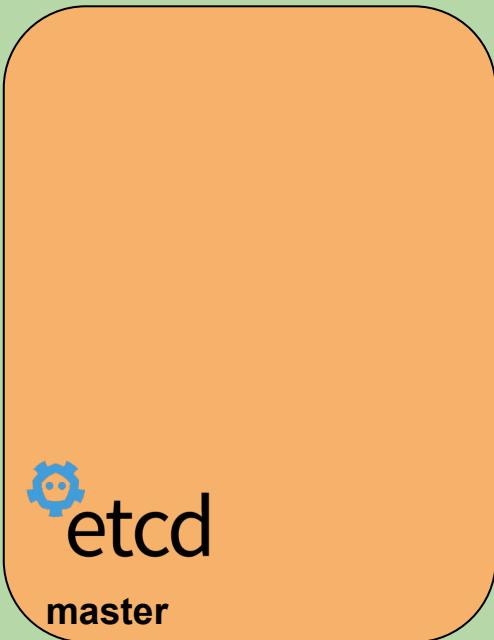
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 - --initial-advertise-peer-urls '<http://localhost:2380>'
 - --initial-cluster 'default=' + localhost:2380
 - --listen-client-urls '<http://localhost:2379>'
 - --listen-peer-urls '<http://localhost:2380>'
 - Solution:
 - "<http://localhost:2380>" -> "[http://\[::1\]:2380](http://[::1]:2380)"

1 - etcd



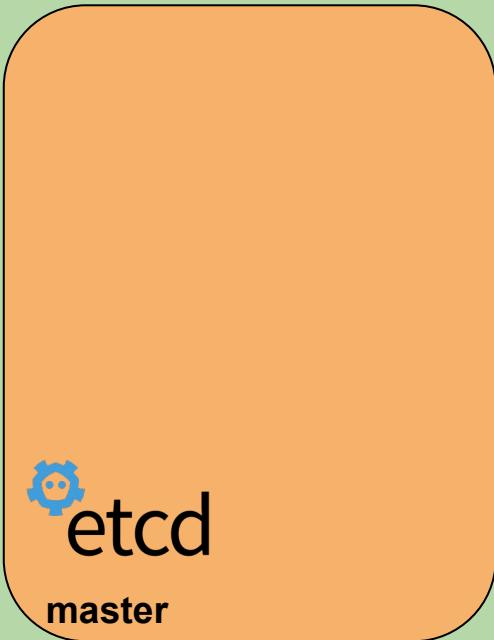
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 - Is that simple? (Yes)

1 - etcd



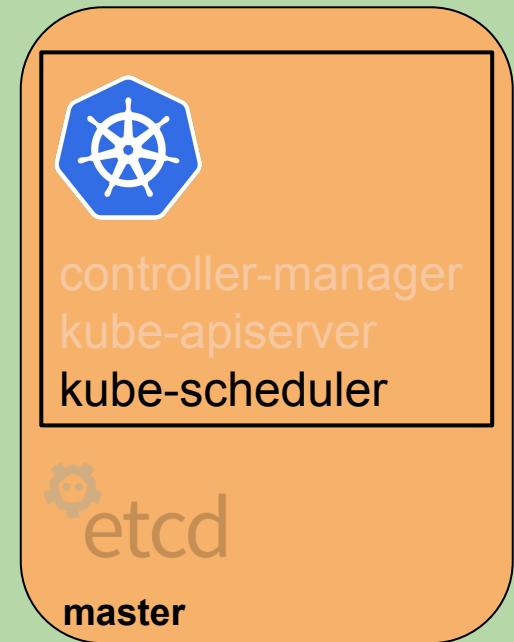
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 - Is that simple? (Yes)
 - What about https? (L4 != L3)

1 - etcd



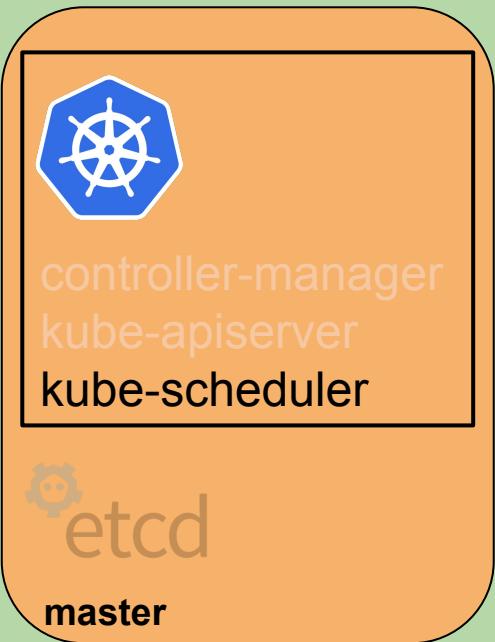
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 - Is that simple? (Yes)
 - What about https? (L4 != L3)
 - I meant the certificates! (Yes they are IPv6 aware)

2 - kube-scheduler



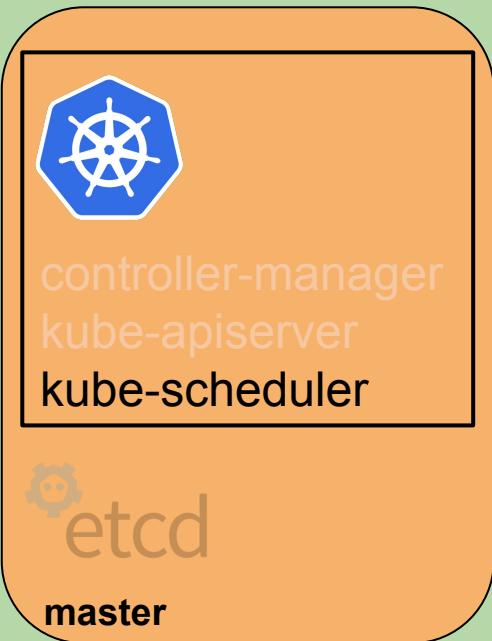
- 32 CLI options

2 - kube-scheduler



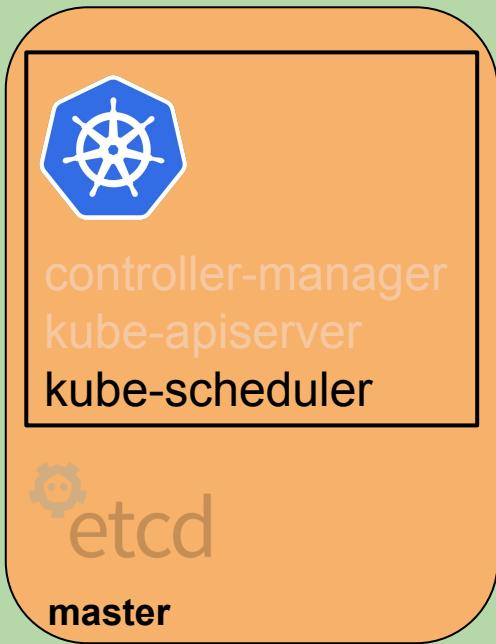
- 32 CLI options
 - ~3 relevant for IPv6
 - --address '0.0.0.0'
 - --master '<http://127.0.0.1:8080>'
 - (--kubeconfig)

2 - kube-scheduler



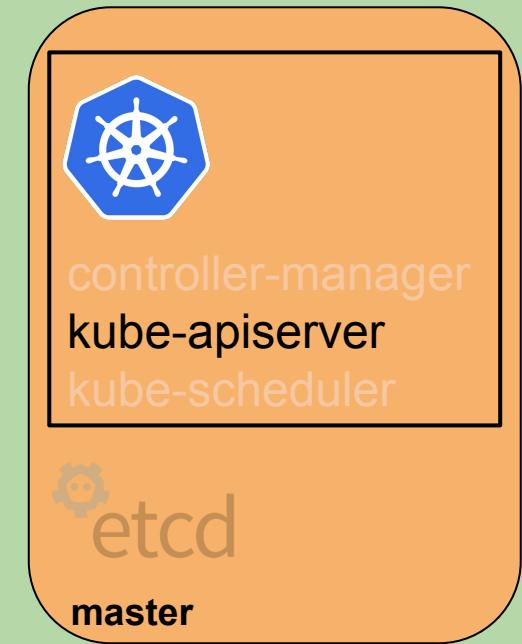
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2 - kube-scheduler



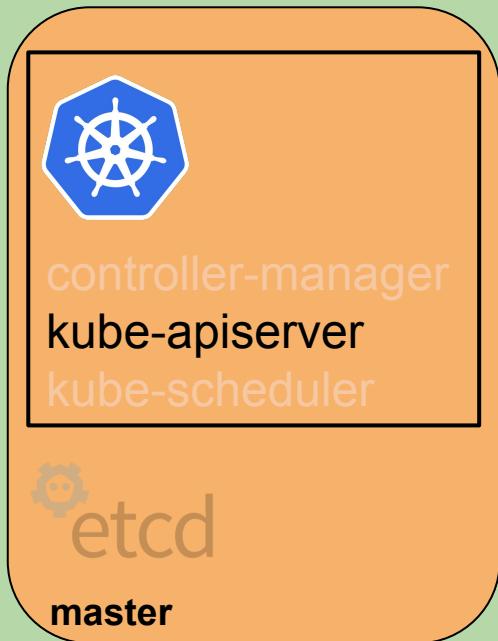
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 - Solution:
 - "<http://127.0.0.1:8080>" -> "[http://\[::1\]:8080](http://[::1]:8080)"
 - “Simple” component

3 - kube-apiserver



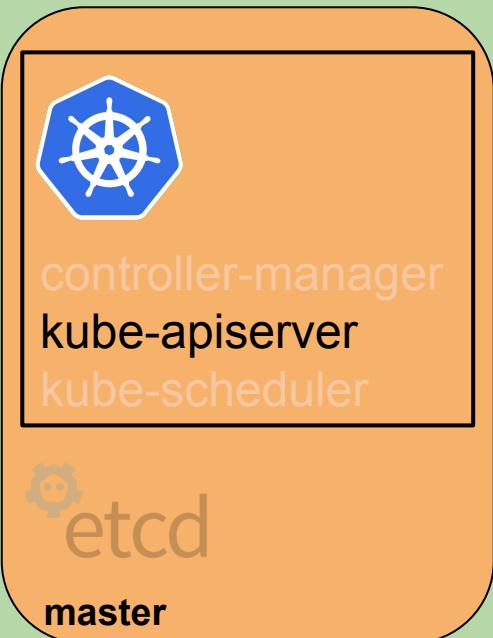
- 120 CLI options!

3 - kube-apiserver



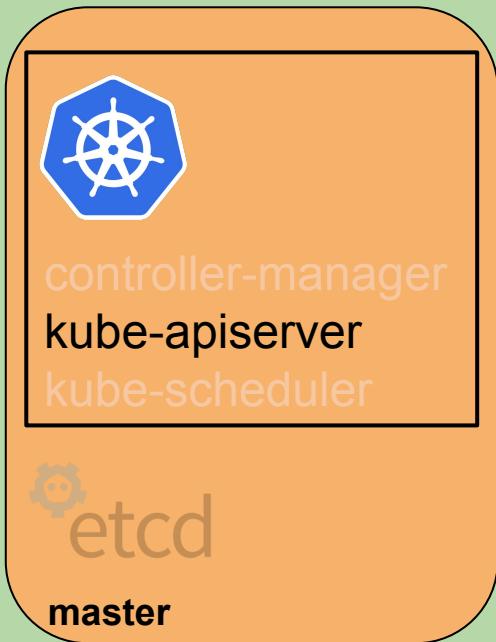
- 120 CLI options!
 - ~5 relevant for IPv6
 - --advertise-address ip
 - --bind-address '0.0.0.0'
 - --etcd-servers 'stringSlice'
 - --insecure-bind-address '0.0.0.0'
 - --service-cluster-ip-range ipNet

3 - kube-apiserver



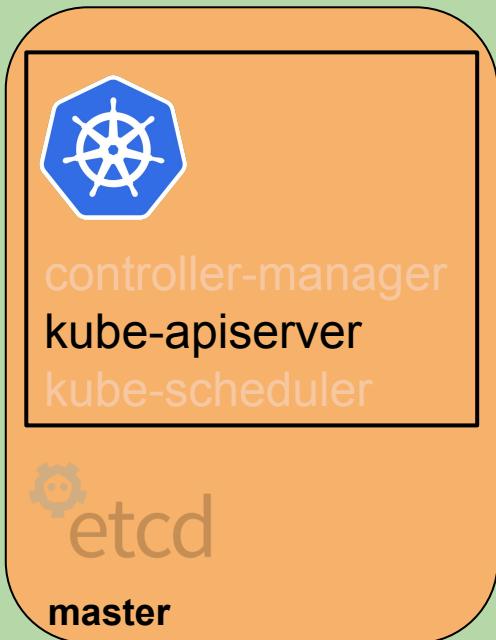
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 - --insecure-bind-address '0.0.0.0'
 - --service-cluster-ip-range ipNet
 - Solution:
 - "<http://localhost:8080>" -> "[http://\[::1\]:8080](http://[::1]:8080)"
- --service-cluster-ip-range fd03::/112
fd03:0000:0000:0000:0000:0000:0000/112

3 - kube-apiserver



- 120 CLI options!
 - ~5 relevant for IPv6
 - --advertise-address ip
 - --bind-address '0.0.0.0'
 - --etcd-servers 'stringSlice'
 - --insecure-bind-address '0.0.0.0'
 - --service-cluster-ip-range ipNet
 - Solution:
 - "<http://localhost:8080>" -> "[http://\[::1\]:8080](http://[::1]:8080)"
 - --service-cluster-ip-range fd03::/112
fd03:0000:0000:0000:0000:0000:0000/112
 - frontend -> fd03::acde
 - backend -> fd03::f00d
 - kube-dns -> fd03::a (assigned by us)

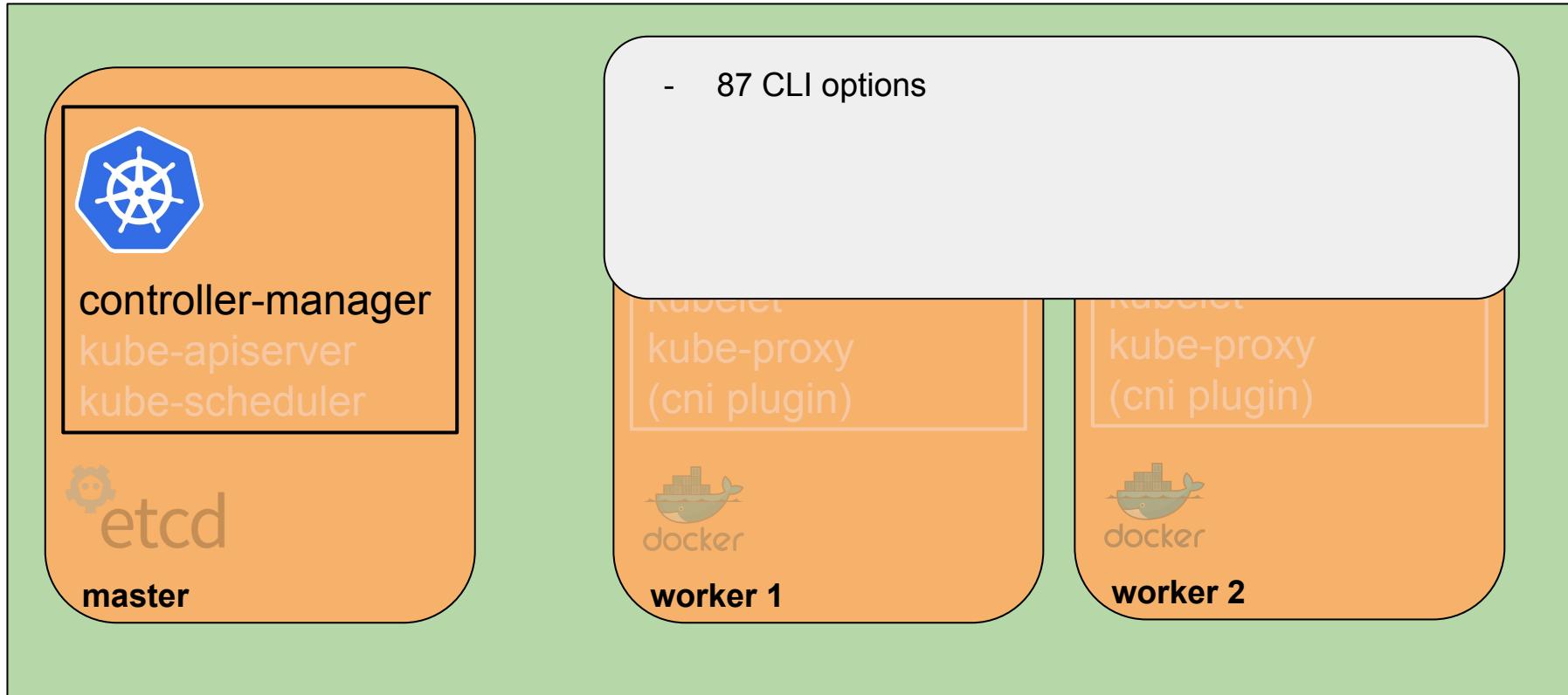
3 - kube-apiserver



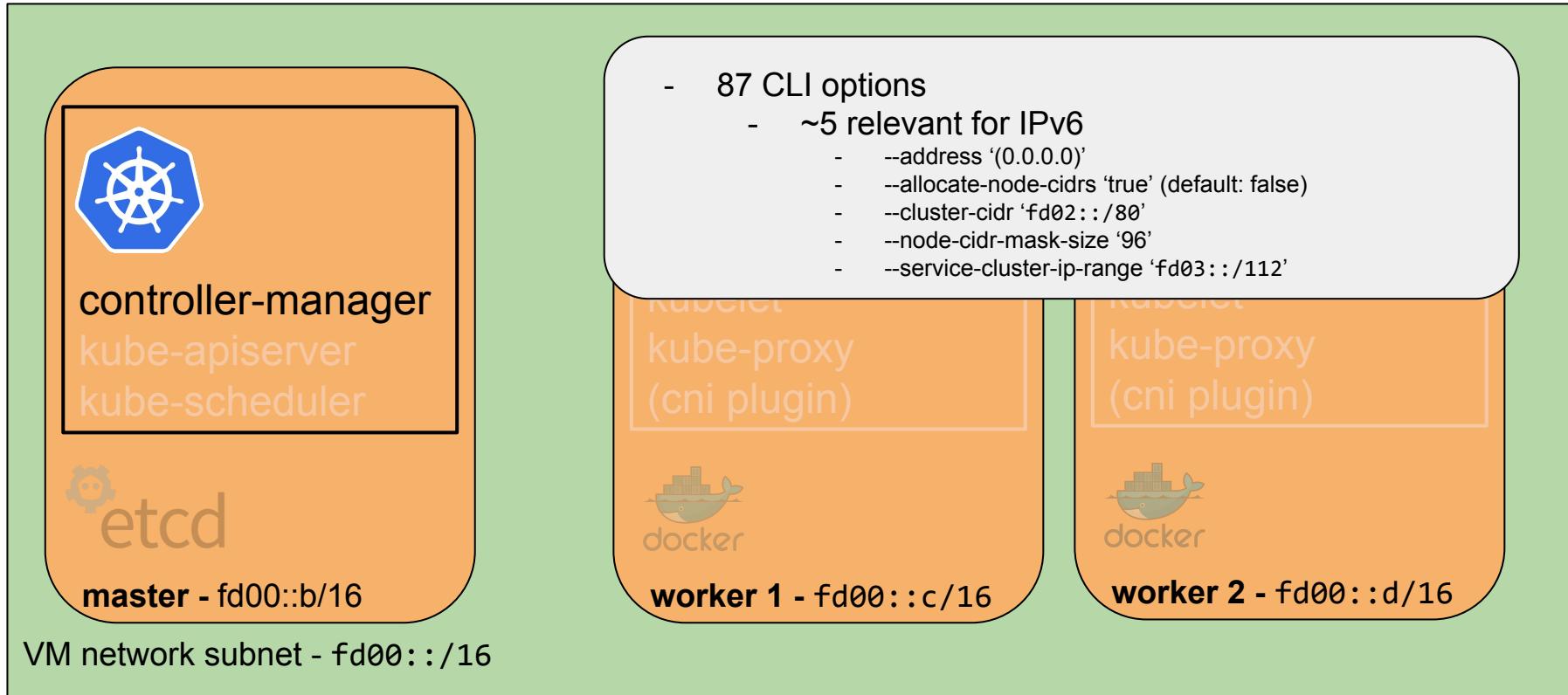
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fd03:0000:0000:0000:0000:0000:0000/112

Do not try this at home with kubernetes < 1.8.0
<https://github.com/kubernetes/kubernetes/pull/43586>

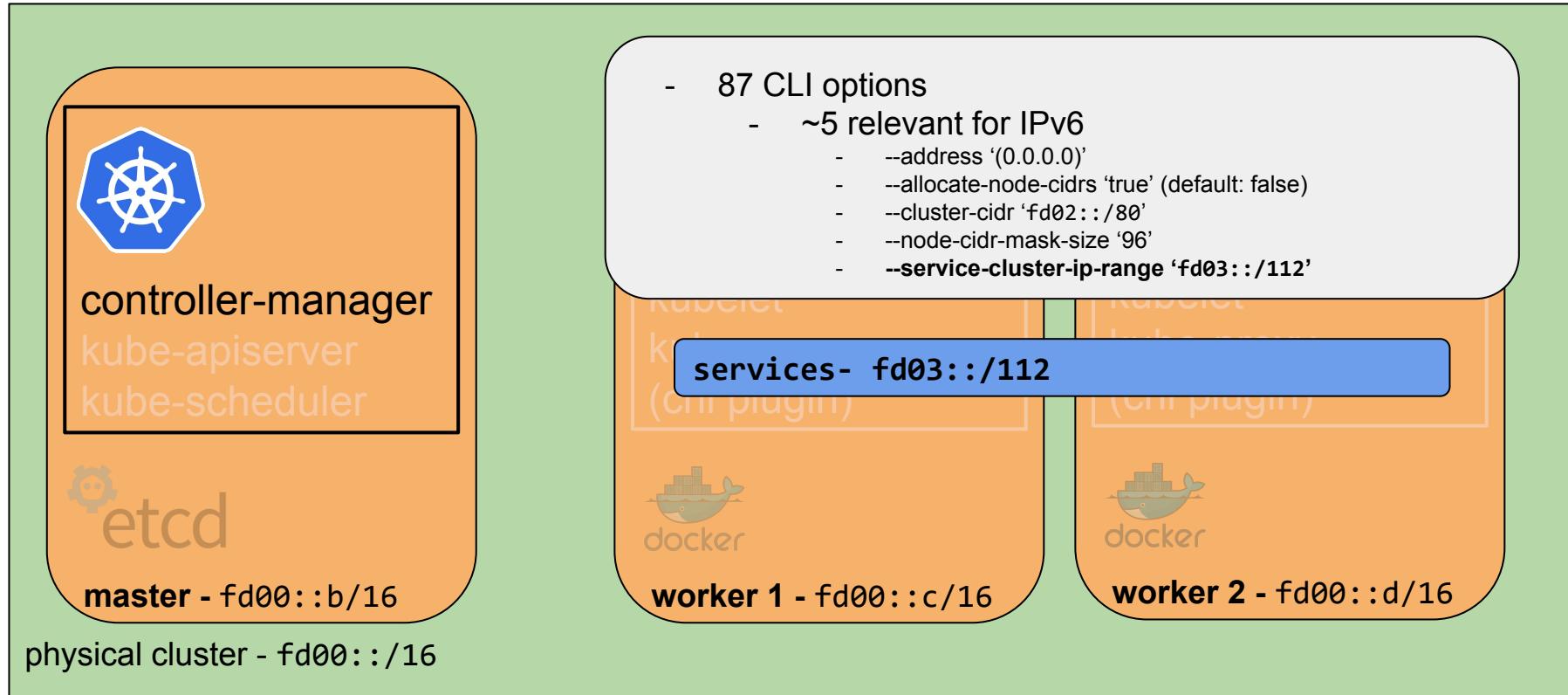
4 - controller-manager



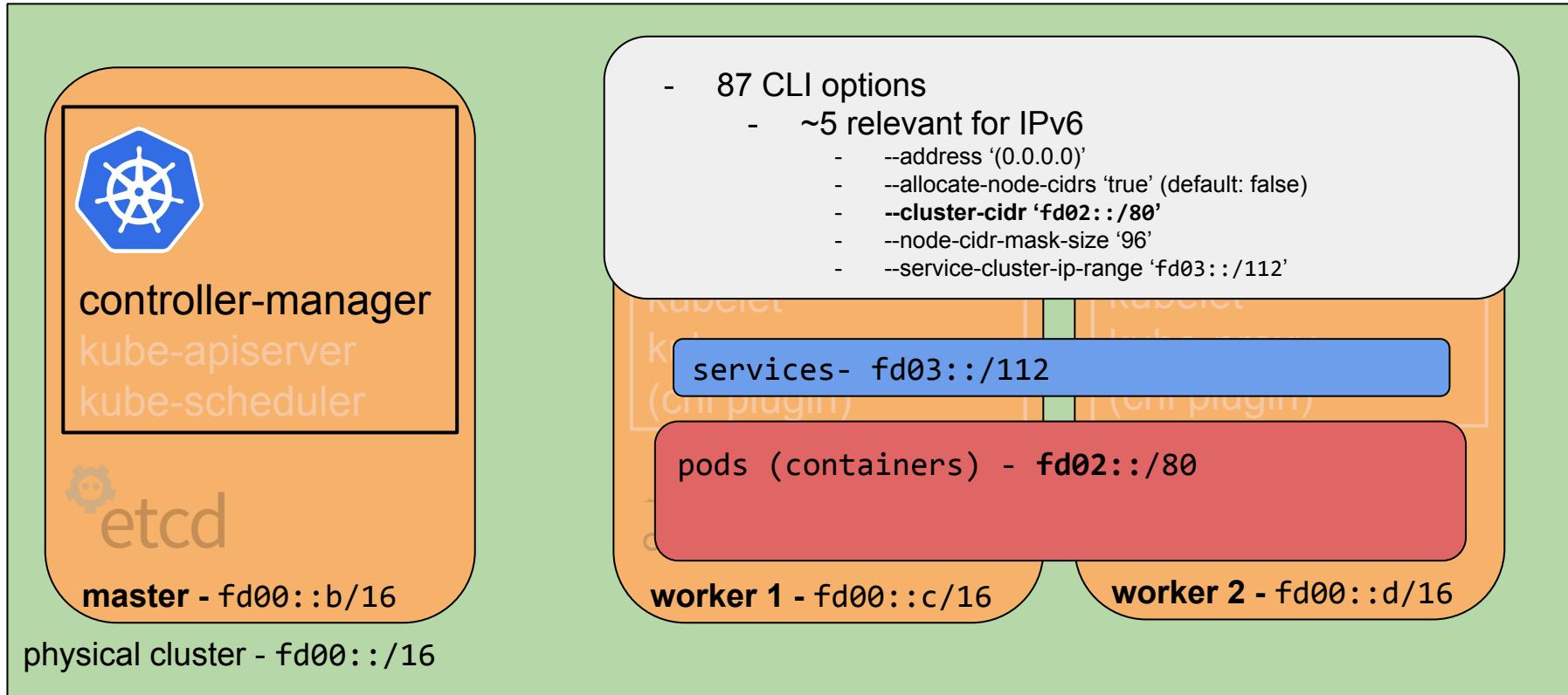
4 - controller-manager



4 - controller-manager



4 - controller-manager



4 - controller-manager

Cluster CIDR

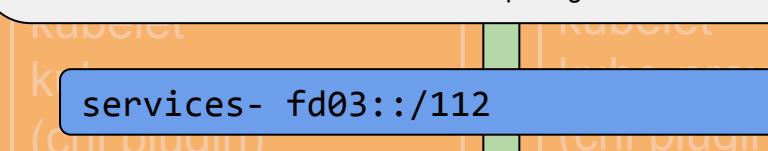
fd02:0:0:0:0:0:0:0/80

- 87 CLI options

- ~5 relevant for IPv6

- --address '(0.0.0.0)'
 - --allocate-node-cidrs 'true' (default: false)
 - **--cluster-cidr 'fd02::/80'**
 - --node-cidr-mask-size '96'
 - --service-cluster-ip-range 'fd03::/112'

physical cluster - fd00::/16



services - fd03::/112

pods (containers) - fd02::/80

worker 1 - fd00::c/16

worker 2 - fd00::d/16

4 - controller-manager

Cluster CIDR

fd02:0:0:0:0:0:0:0/80

Pod CIDR - 1st node

fd02:0:0:0:0:0:0:0/96

- 87 CLI options

- ~5 relevant for IPv6

- --address '(0.0.0.0)'
 - --allocate-node-cidrs 'true' (default: false)
 - --cluster-cidr 'fd02::/80'
 - **--node-cidr-mask-size '96'**
 - --service-cluster-ip-range 'fd03::/112'

services - fd03::/112

pods (containers) - fd02::/80

worker 1 - fd00::c/16

worker 2 - fd00::d/16

physical cluster - fd00::/16

4 - controller-manager

Cluster CIDR

fd02:0:0:0:0:0:0:0/80

Pod CIDR - 1st node

fd02:0:0:0:0:0:0:0/96

- 87 CLI options

- ~5 relevant for IPv6

- --address '(0.0.0.0)'
 - --allocate-node-cidrs 'true' (default: false)
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physical cluster - fd00::/16

4 - controller-manager

Cluster CIDR

fd02:0:0:0:0:0:0:0/80

Pod CIDR - 1st node

fd02:0:0:0:0:0:0:0/96

Pod CIDR - 2nd node

fd02:0:0:0:0:1:0:0/96

physical cluster - **fd00::/16**

- 87 CLI options

- ~5 relevant for IPv6

- --address '(0.0.0.0)'
 - --allocate-node-cidrs 'true' (default: false)
 - --cluster-cidr 'fd02::/80'
 - --node-cidr-mask-size '96'
 - --service-cluster-ip-range 'fd03::/112'

services - fd03::/112

pods (containers) - fd02::/80

fd02::/96

fd02:0:0:0:0:1::/96

worker 1 - fd00::c/16

worker 2 - fd00::d/16

4 - controller-manager

Cluster CIDR

fd02:0:0:0:0:0:0:0/80

Pod CIDR - 1st node

fd02:0:0:0:0:0:0:0/96

Pod CIDR - 2nd node

fd02:0:0:0:0:1:0:0/96

...

Pod CIDR - 65536th node

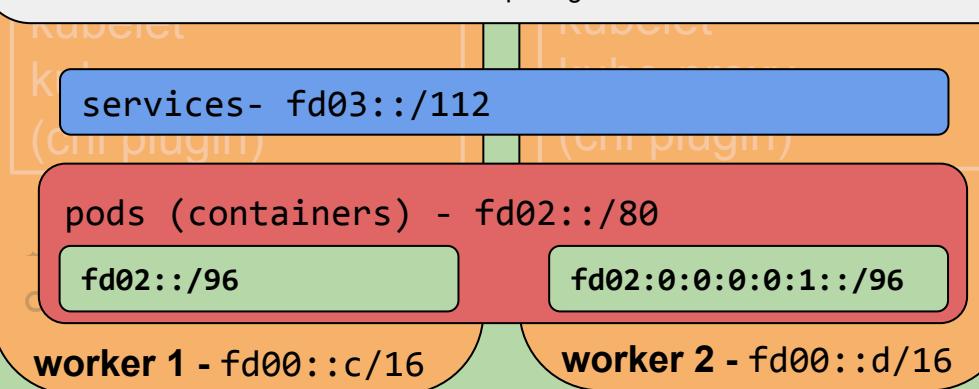
fd02:0:0:0:0:ffff:0:0/96

physical cluster - fd00::/16

- 87 CLI options

- ~5 relevant for IPv6

- --address '(0.0.0.0)'
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- --service-cluster-ip-range 'fd03::/112'



4 - controller-manager

Cluster CIDR

fd02::0::0::0::0::0/80

WHAT IF I TOLD YOU

DON'T NEED TO CARE ABOUT IP ADDRESSES

imgflip.com

fd02:0:0:0:0:ffff:0:0/96

physical cluster - fd00::/16

- 87 CLI options

- ~5 relevant for IPv6

- --address '(0.0.0.0)'
 - --allocate-node-cidrs 'true' (default: false)
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 - --service-cluster-ip-range 'fd03::/112'

CIDR

Kubernetes

services - fd03::/112

plugin)

(CNI plugin)

ds (containers) - fd02::/80

fd02::/96

fd02:0:0:0:0:1::/96

worker 1 - fd00::c/16

worker 2 - fd00::d/16

5 - docker

- a runtime container
- network plumbing made by:
 - libnetwork (IPv6 only with IPv4)
 - **CNI**

blog.kubernetes.io/2016/01/why-Kubernetes-doesnt-use-libnetwork.html

kube-apiserver
kube-scheduler

etcd

kube-proxy
(cni plugin)



worker 1

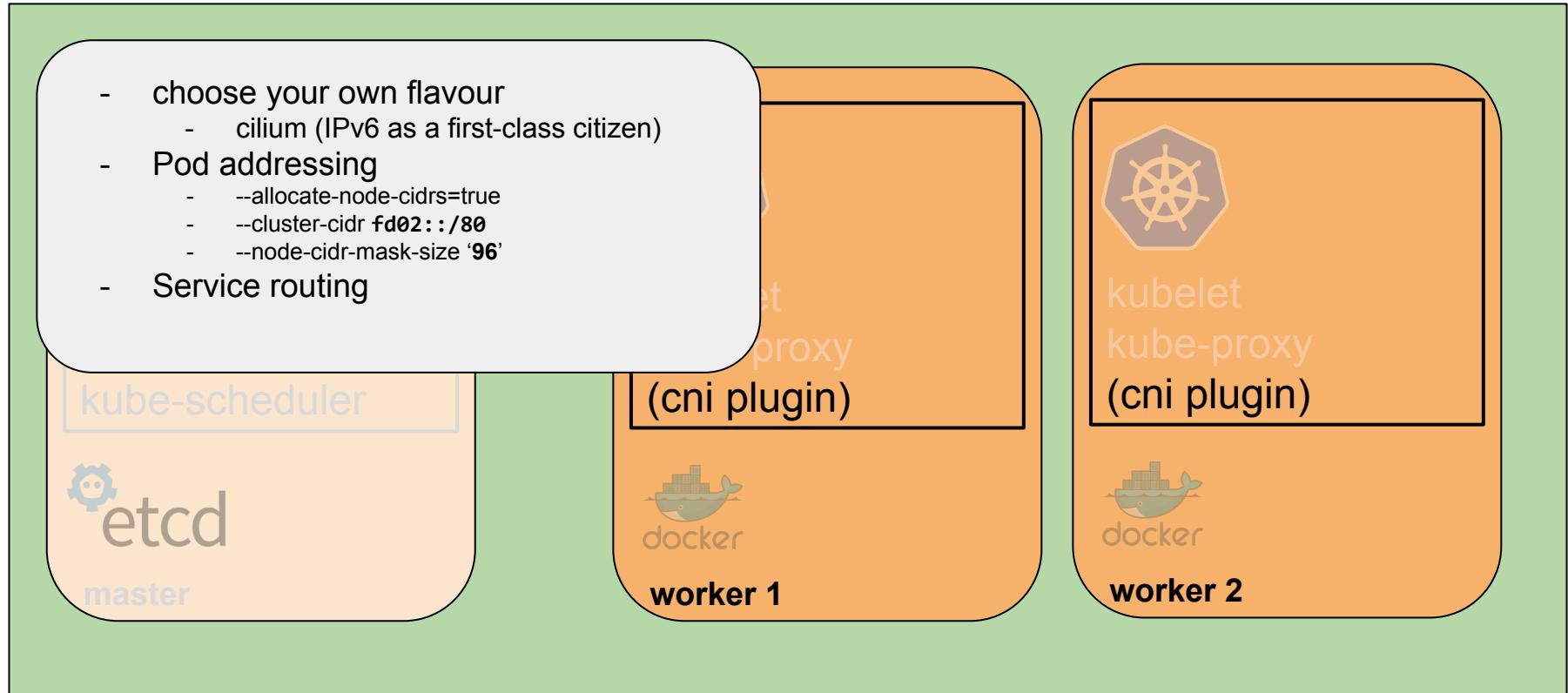
kubelet
kube-proxy
(cni plugin)



worker 2

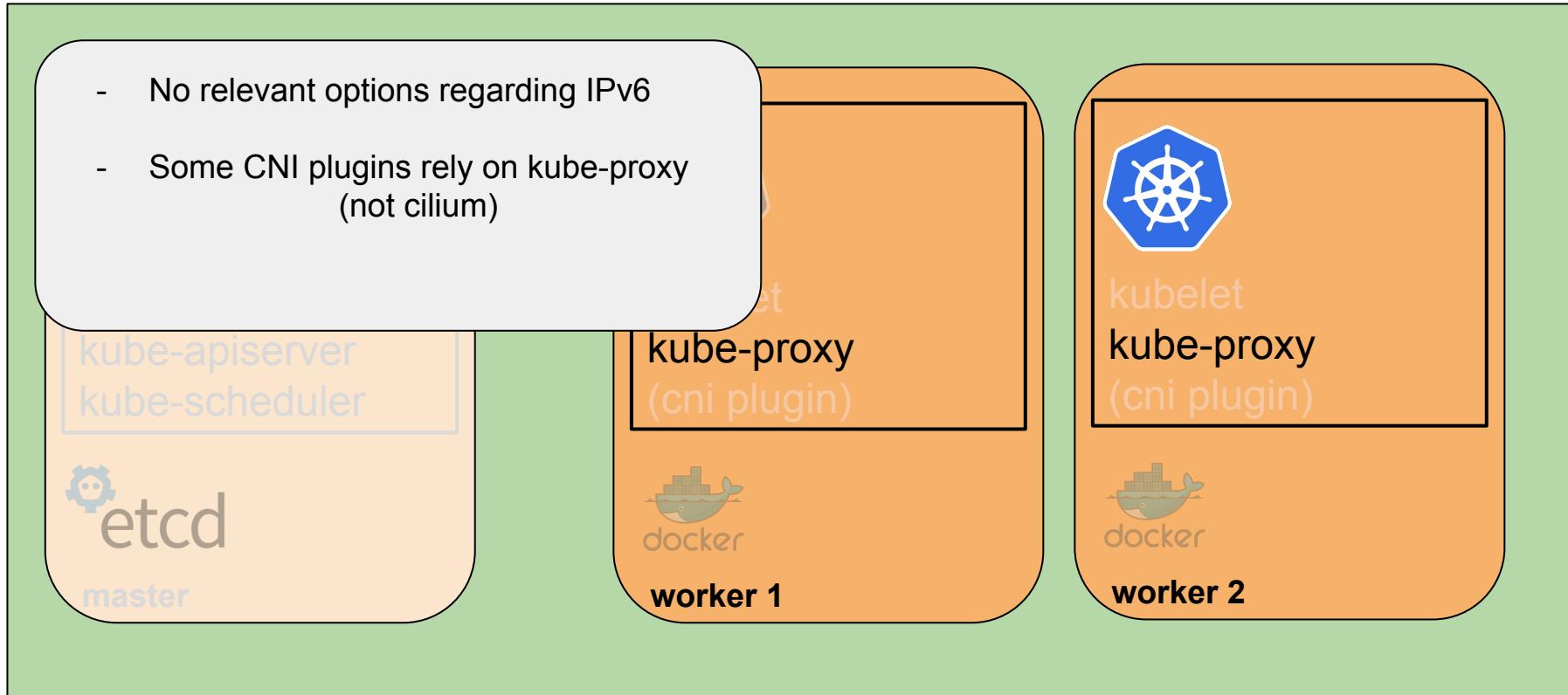
6 - cni plugin

- choose your own flavour
 - cilium (IPv6 as a first-class citizen)
- Pod addressing
 - `--allocate-node-cidrs=true`
 - `--cluster-cidr fd02::/80`
 - `--node-cidr-mask-size '96'`
- Service routing



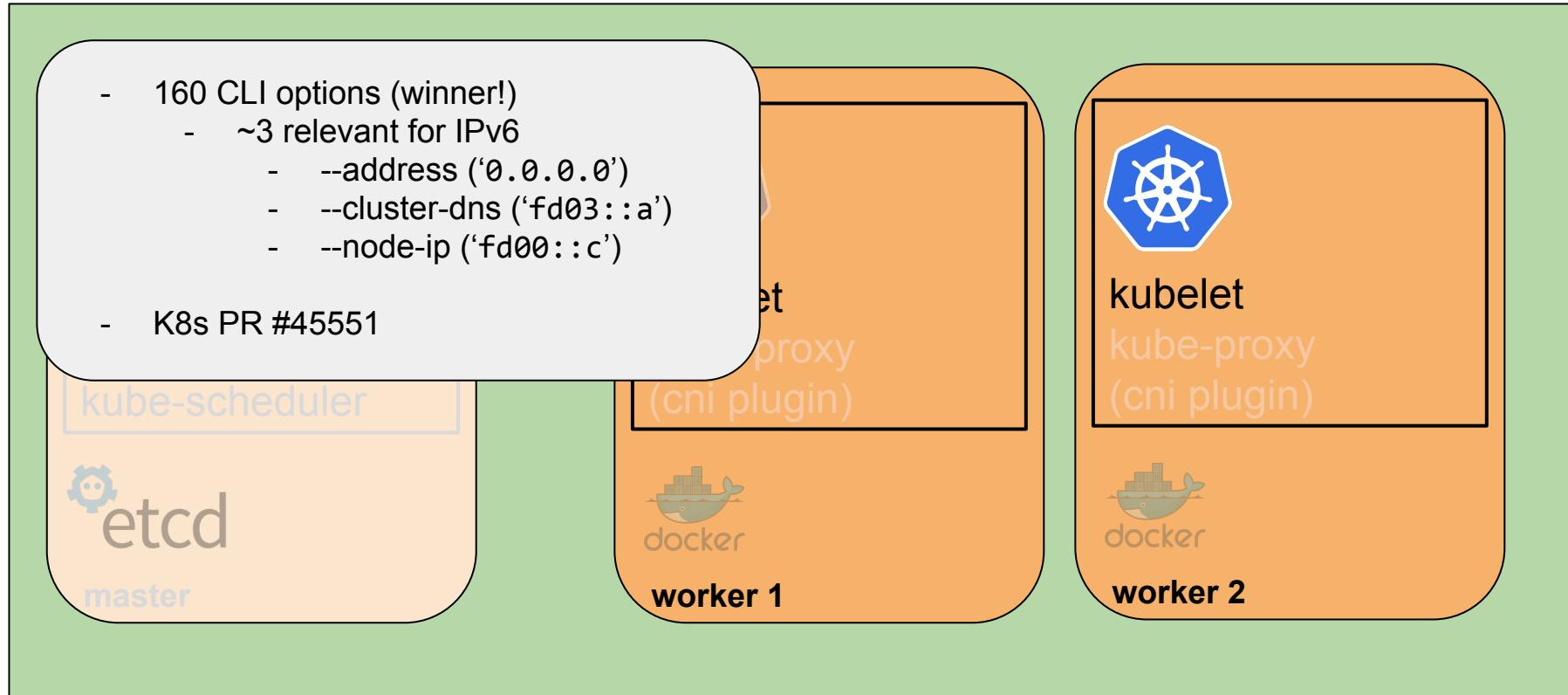
7 - kube-proxy

- No relevant options regarding IPv6
- Some CNI plugins rely on kube-proxy (not cilium)

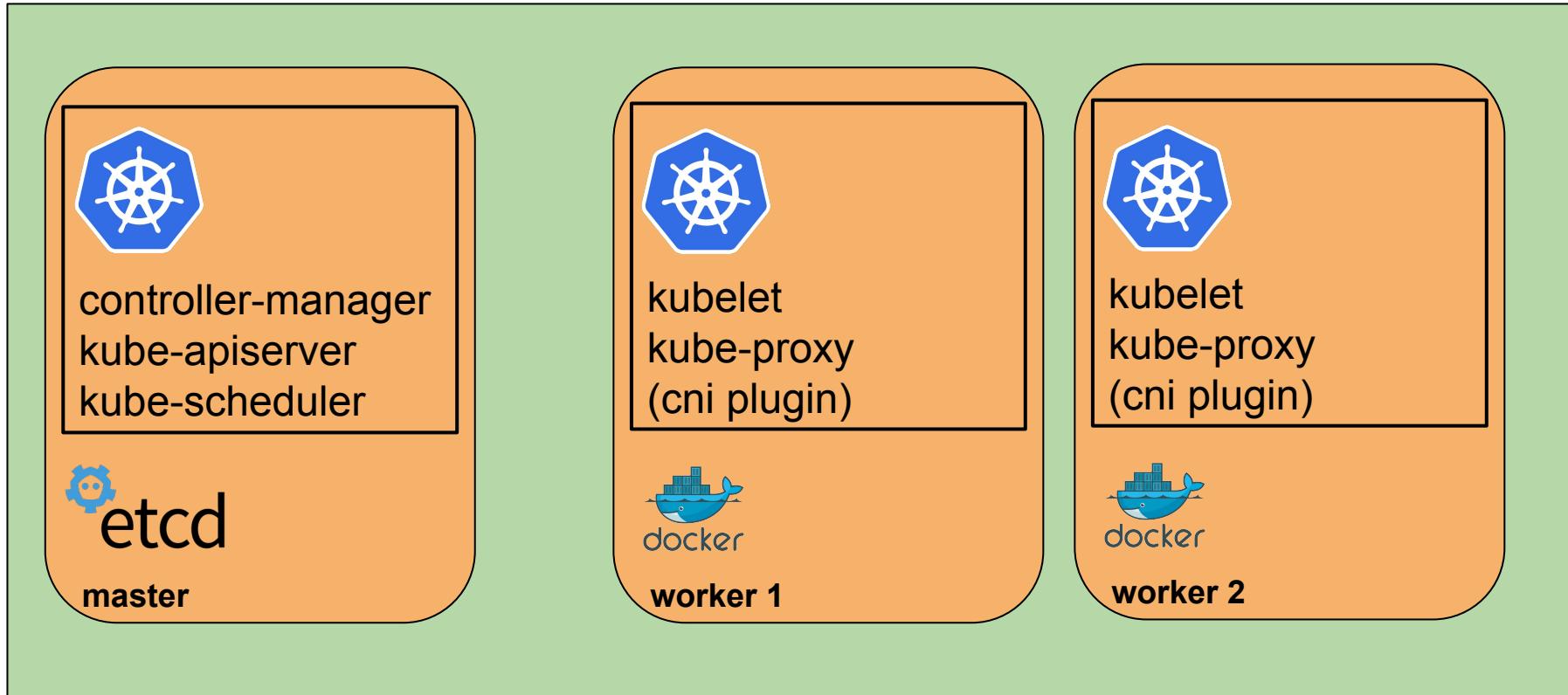


8 - kubelet

- 160 CLI options (winner!)
 - ~3 relevant for IPv6
 - --address ('0.0.0.0')
 - --cluster-dns ('fd03::a')
 - --node-ip ('fd00::c')
- K8s PR #45551

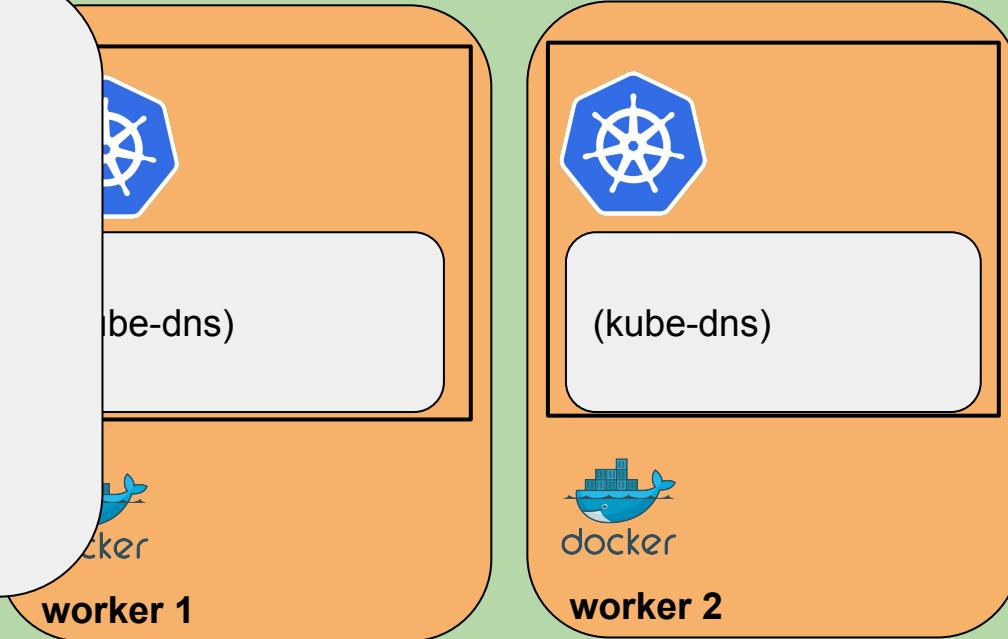


Kubernetes cluster



Where's kube-dns?

- DNS for the k8s cluster
- Serves all DNS requests

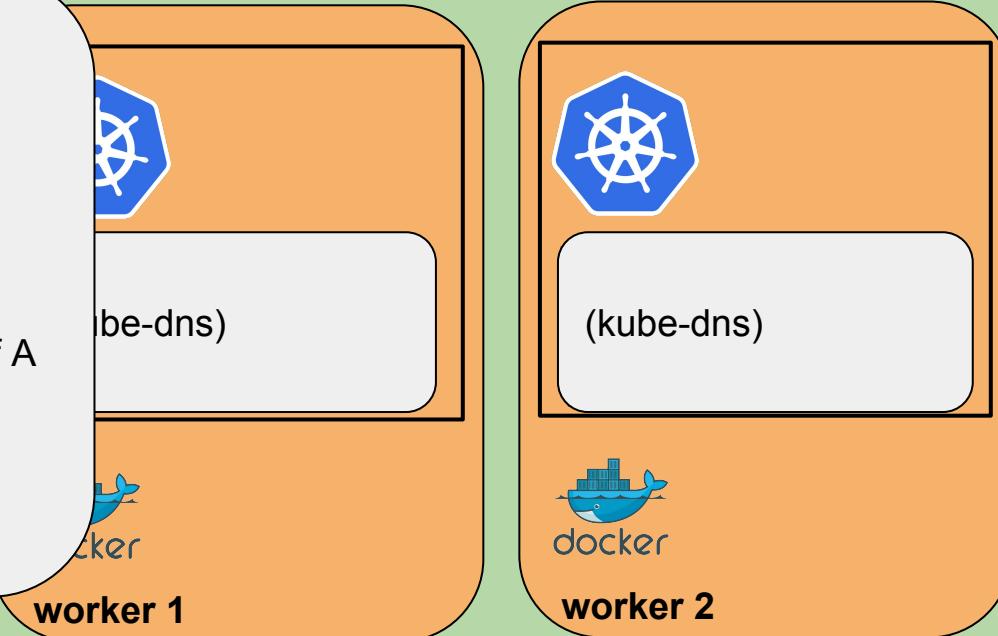


Where's kube-dns?

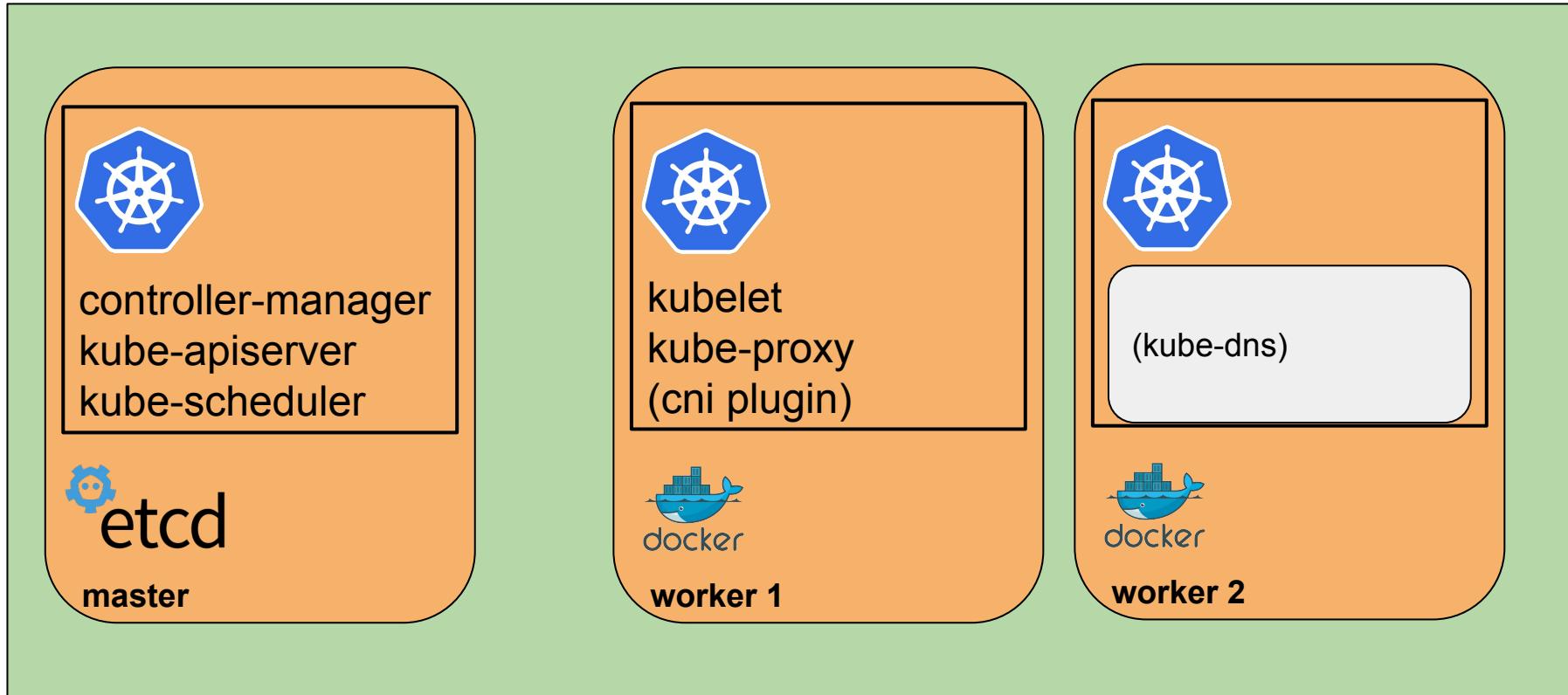
- DNS for the k8s cluster
- Serves all DNS requests
- Deployment k8s spec file
- Service k8s spec file
- 1 Change in Deployment file
 - probe for AAAA instead of A

```
--probe=kubedns,[::1]:10053,kubernetes.default.svc.cluster.local,5,AAAA  
--probe=dnsmasq,[::1]:53,kubernetes.default.svc.cluster.local,5,AAAA
```

master

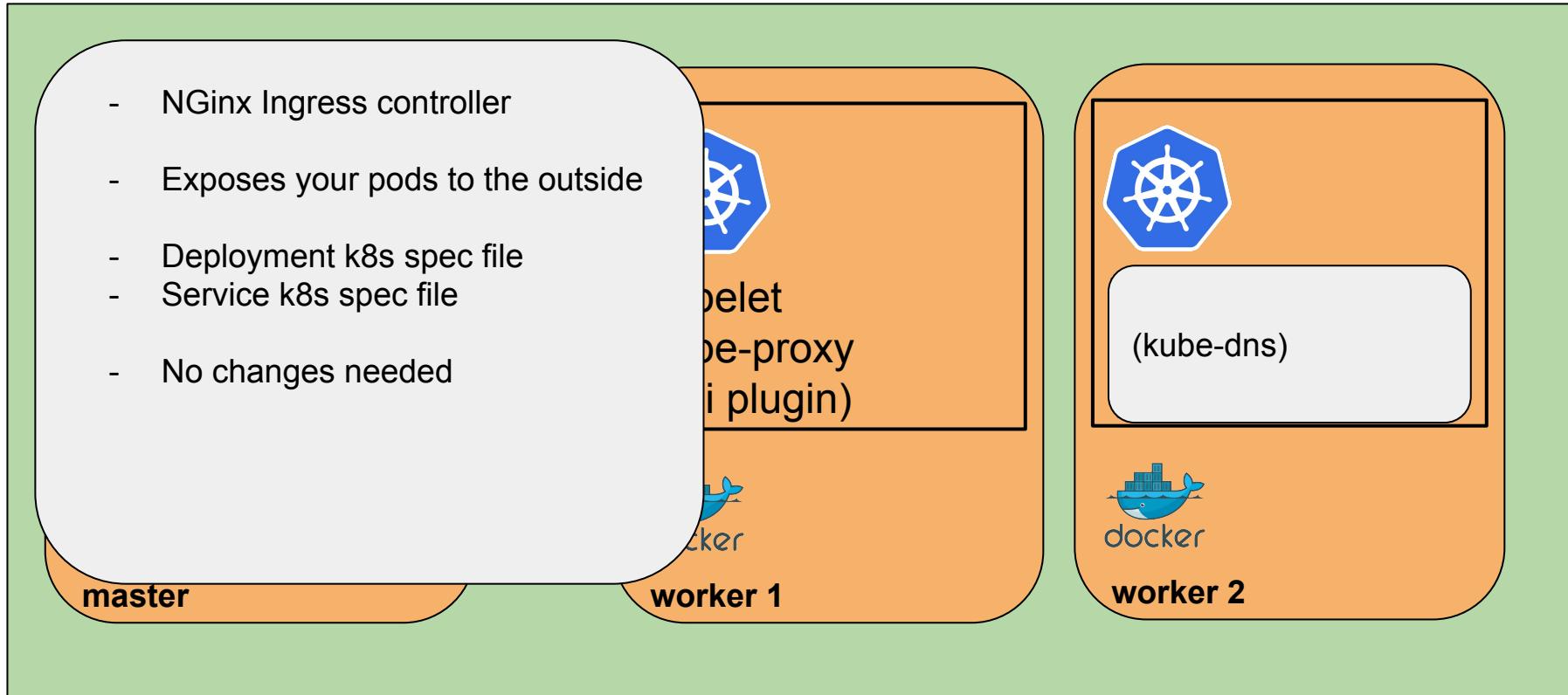


Where's kube-dns?

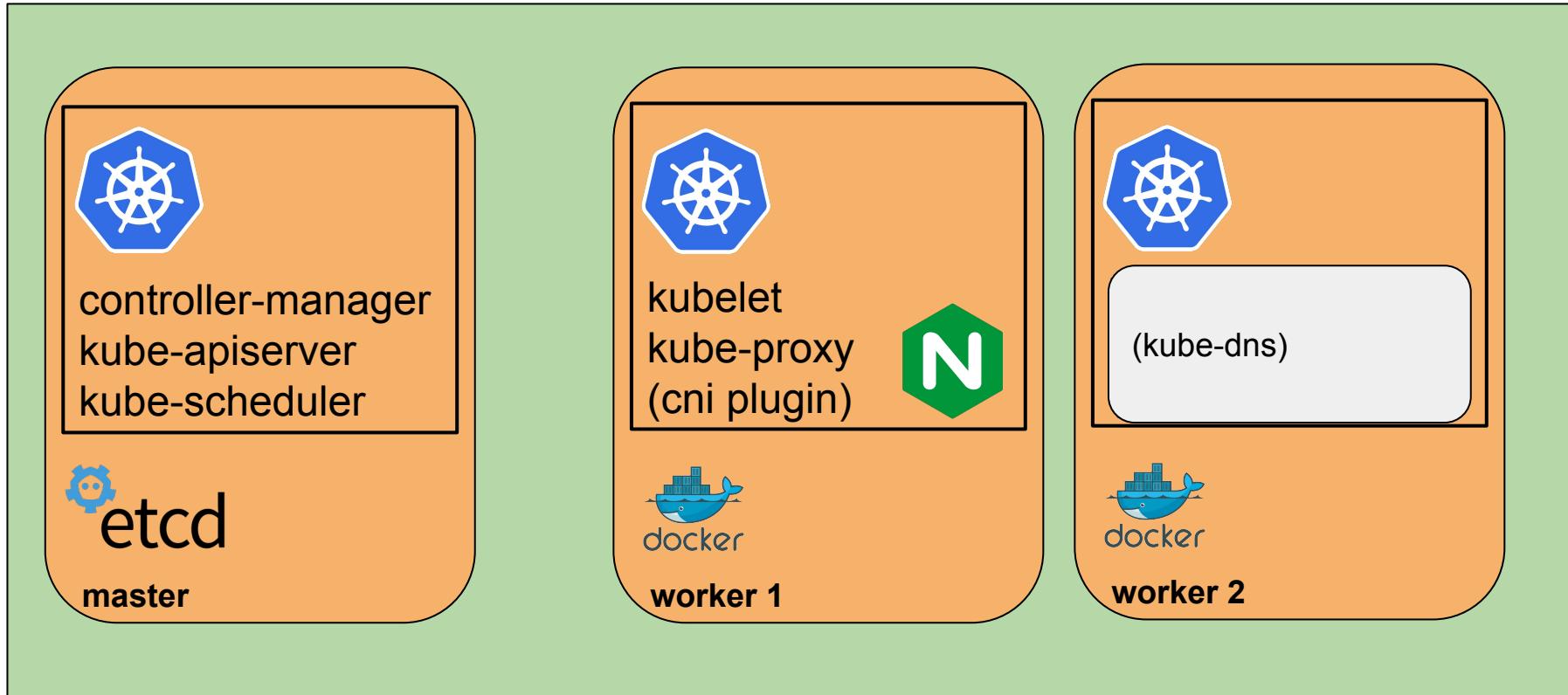


Where's ingress?

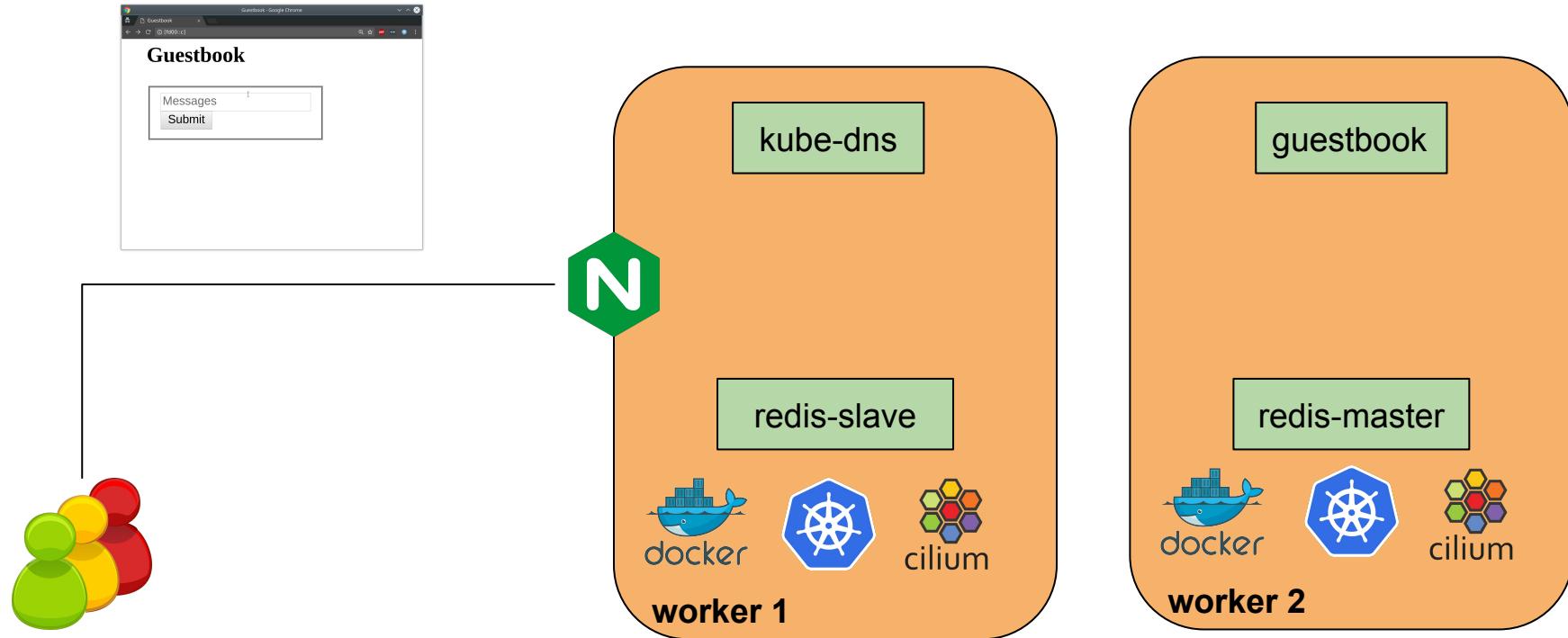
- NGinx Ingress controller
- Exposes your pods to the outside
- Deployment k8s spec file
- Service k8s spec file
- No changes needed



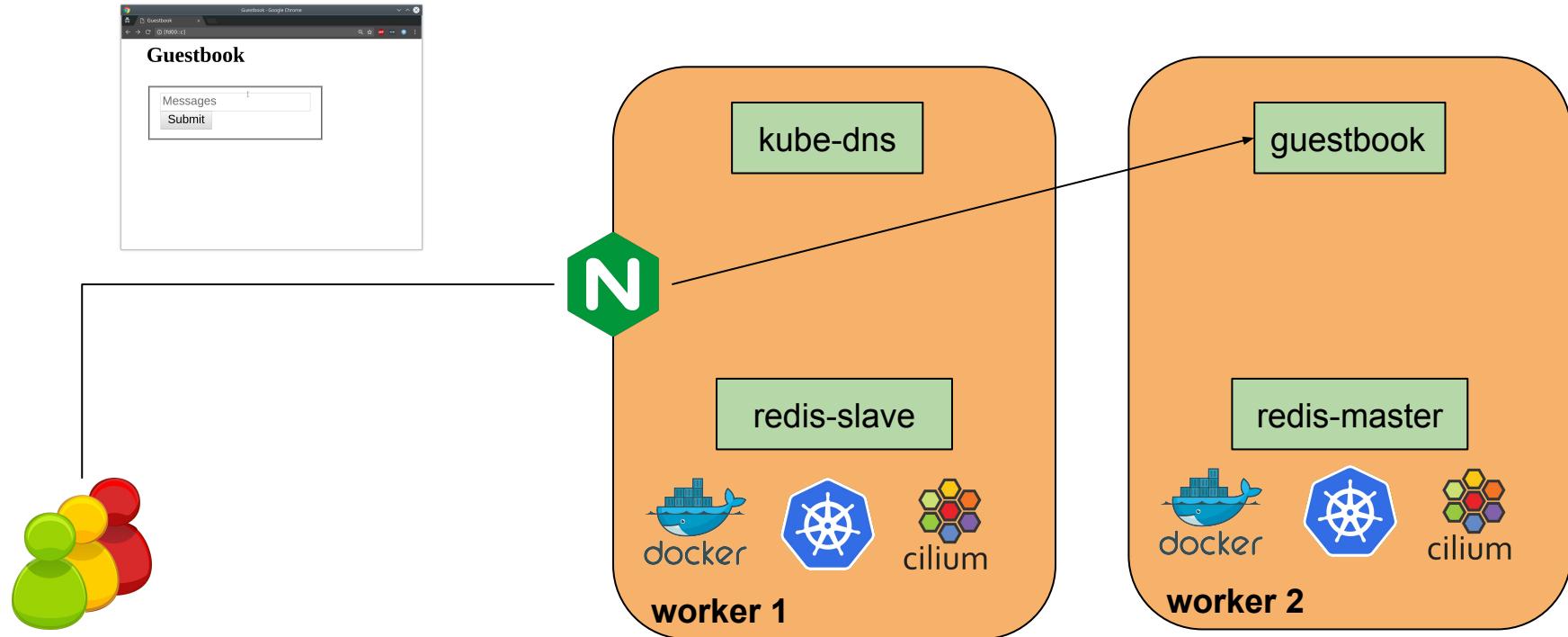
Where's ingress?



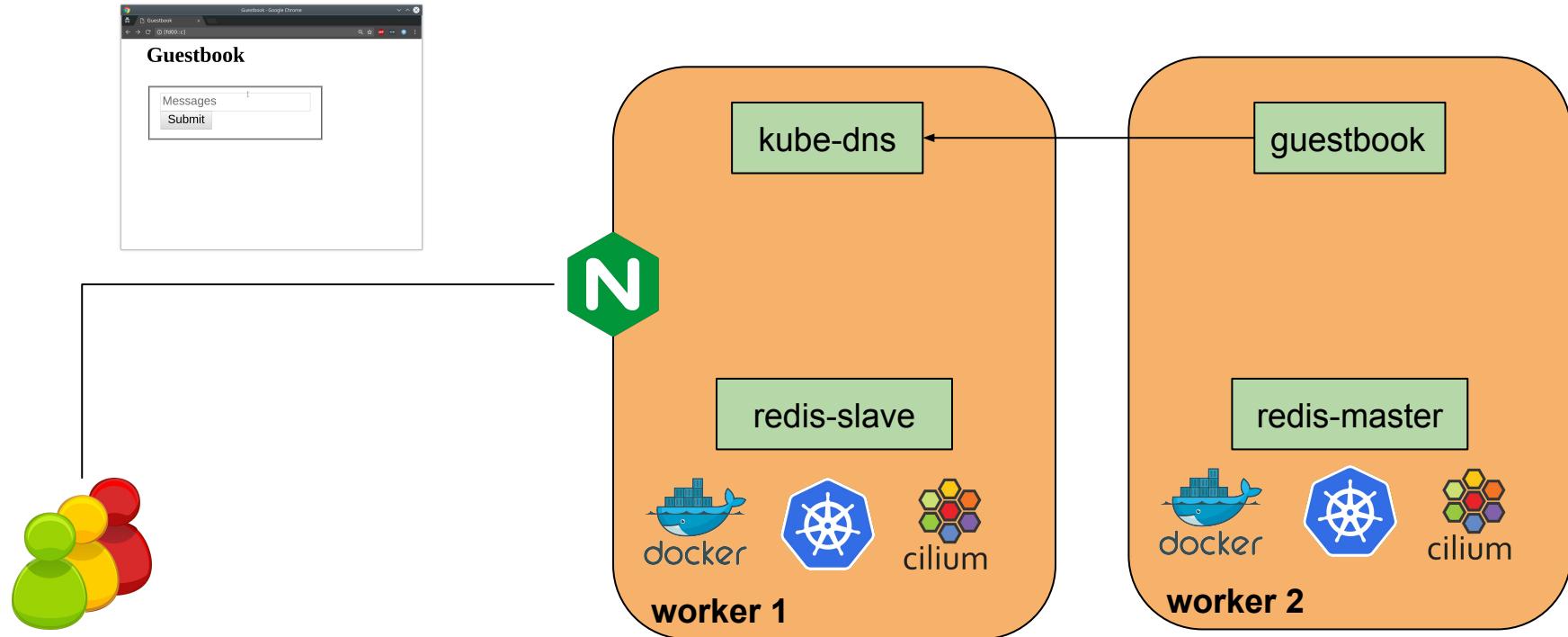
Kubernetes cluster - demo!



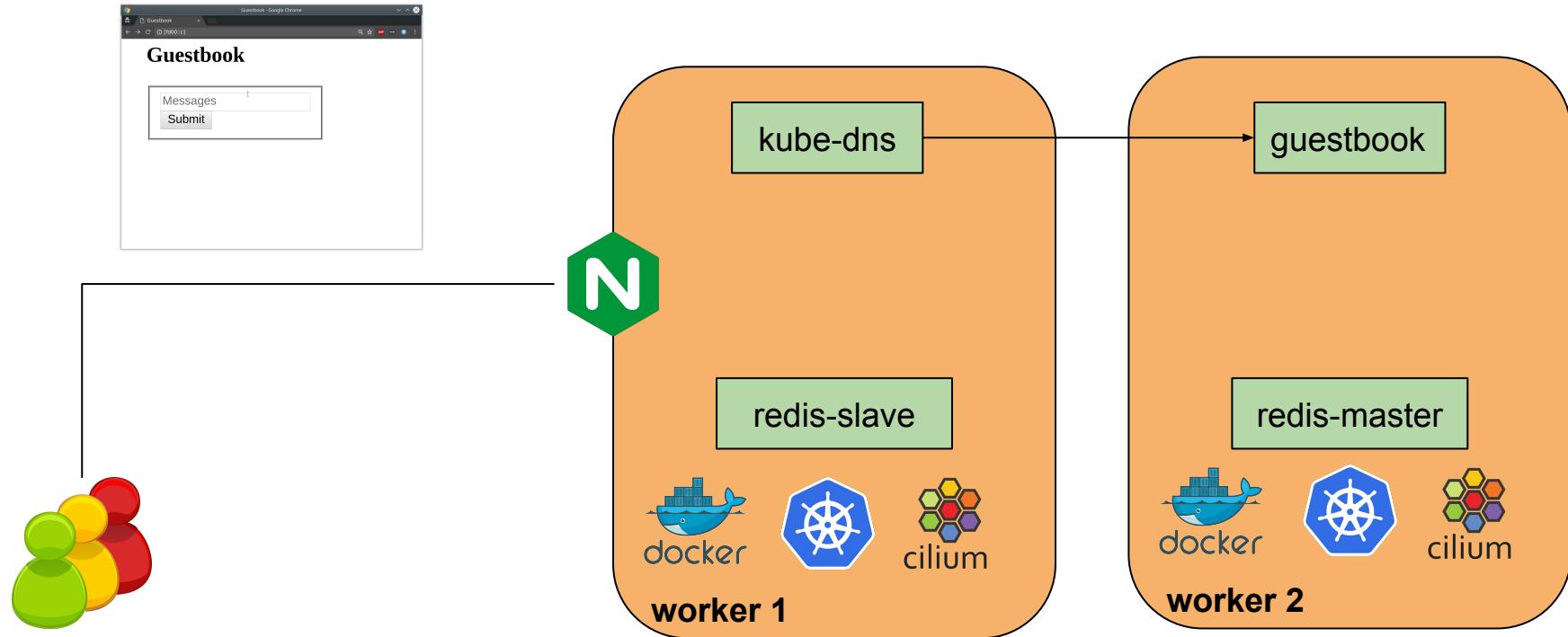
Kubernetes cluster - demo!



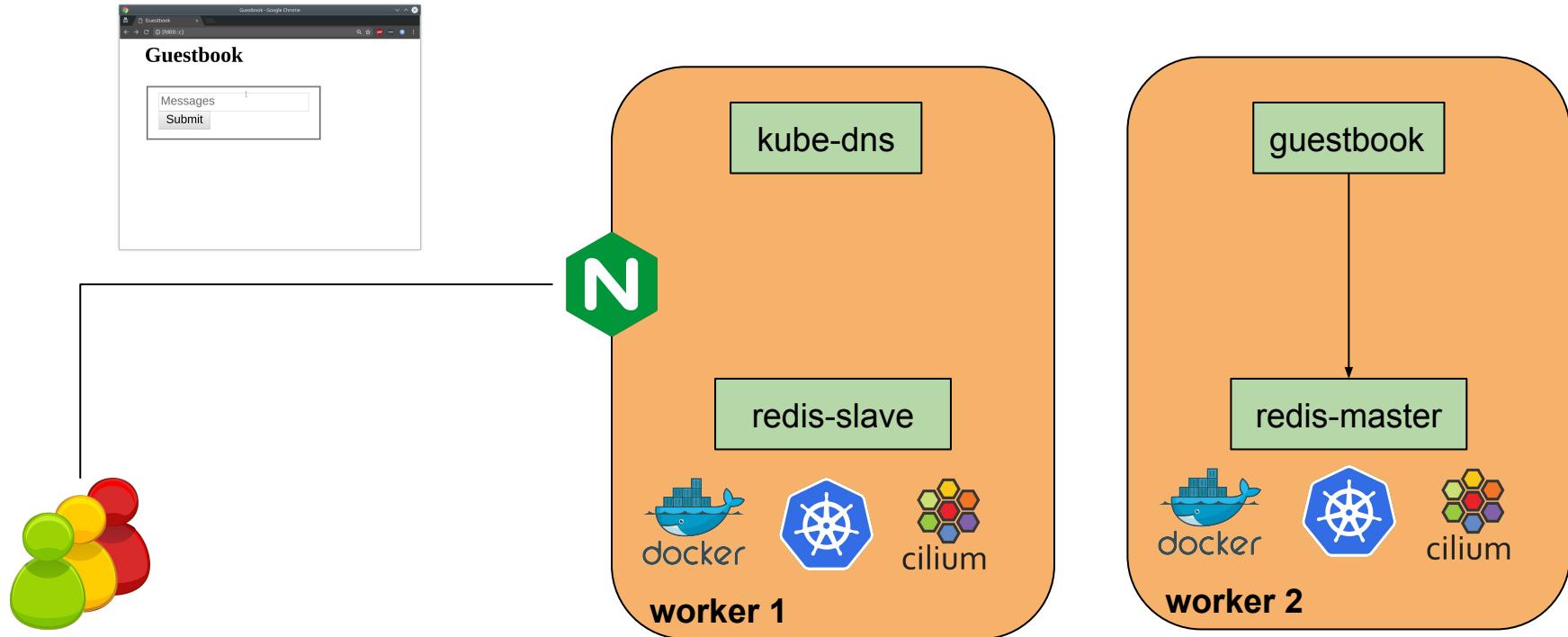
Kubernetes cluster - demo!



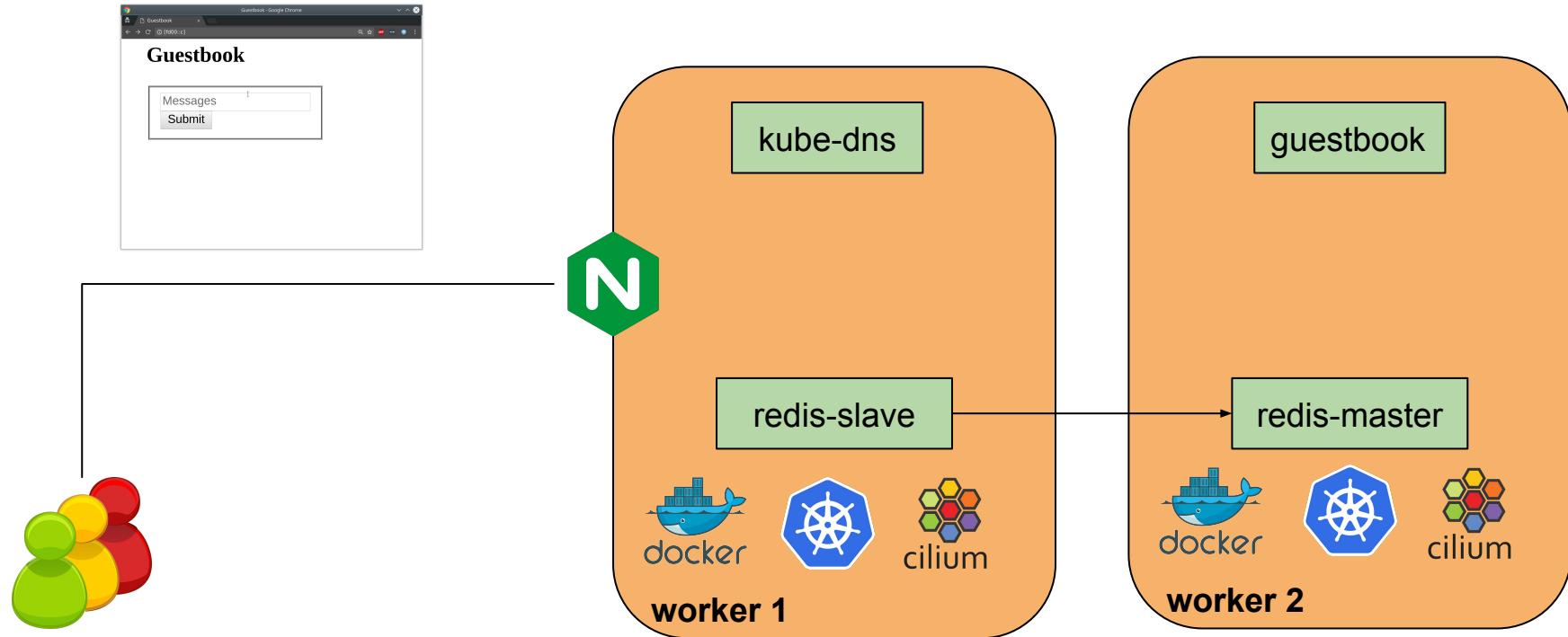
Kubernetes cluster - demo!



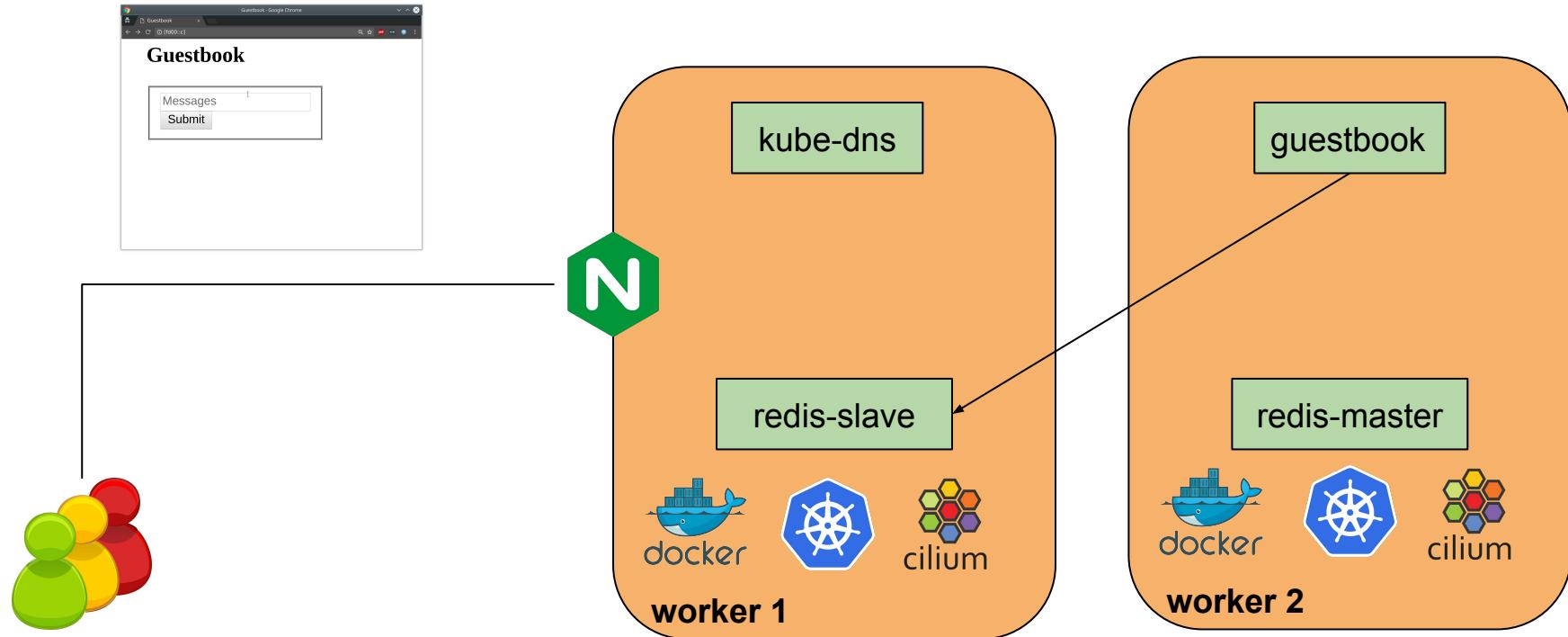
Kubernetes cluster - demo!



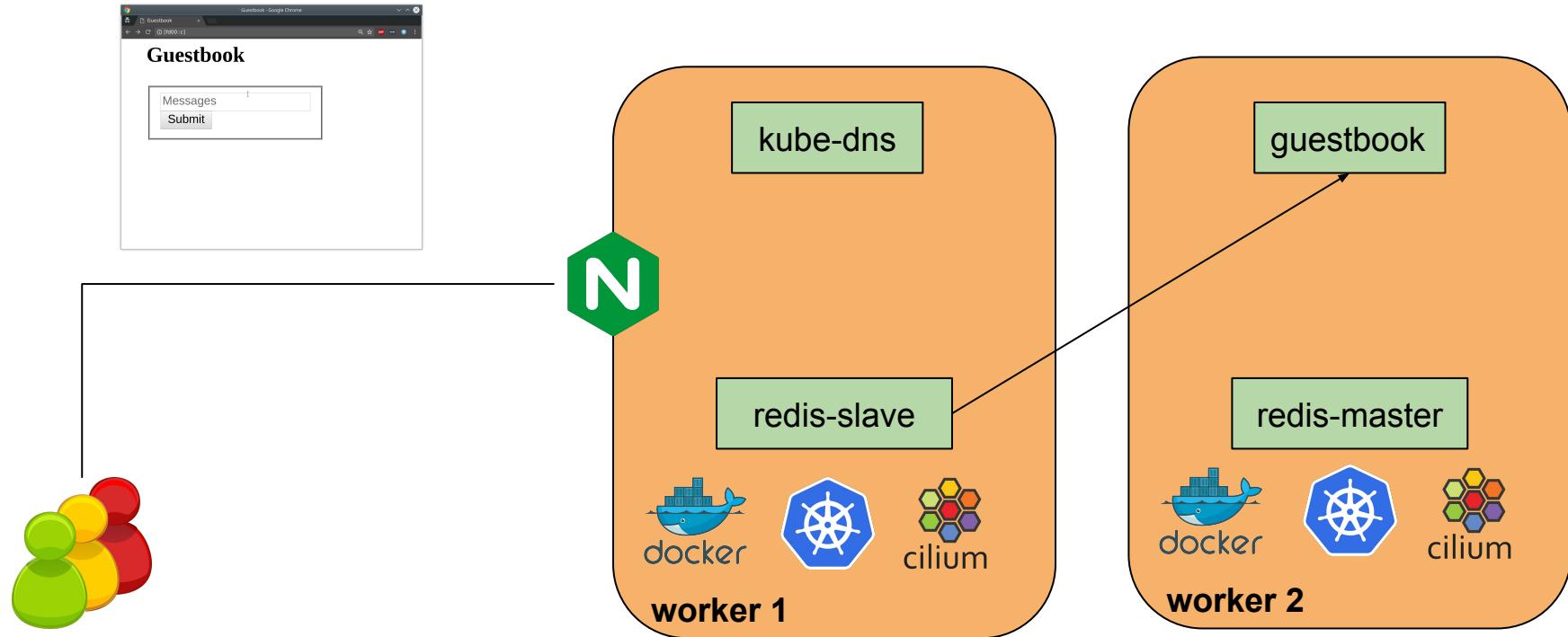
Kubernetes cluster - demo!



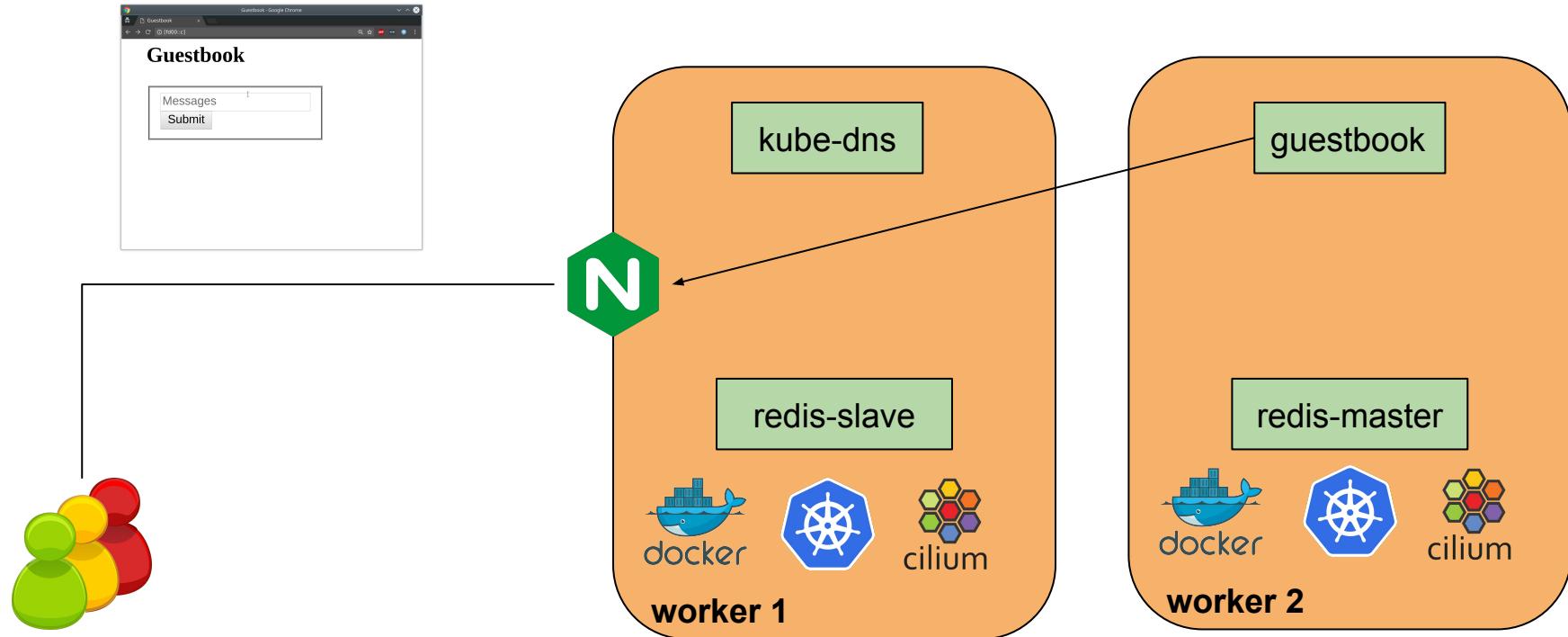
Kubernetes cluster - demo!



Kubernetes cluster - demo!



Kubernetes cluster - demo!



Final thoughts

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- Kubernetes is getting ready
 - TODO:
 - Dual stack! - GH #27398
 - Kubelet's node IP option with IPv6 - PR #45551
 - Waive IPv6 prefix size limit for cluster CIDR - PR #52033
 - Kubeadm

Final thoughts

- Kubernetes has lots of CLI options!
- IPv6 is coming!
- Kubernetes is getting ready
 - TODO:
 - Dual stack! - GH #27398
 - Kubelet's node IP option with IPv6 - PR #45551
 - Waive IPv6 prefix size limit for cluster CIDR - PR #52033
 - Kubeadm
- Unless you try it you'll never find out.



We are on Booth 501
<https://www.cilium.io>

Thank You!

Q & A

André Martins
DM on twitter: @aanm_

Coming next... @ 2:50 pm in Diamond Ballroom 6 (this room)

Cilium - Container Security and Networking Using BPF and XDP
By Thomas Graf, Covalent

Image links

<https://askoramps.org/files/2016/08/pets1.jpg>
<https://dimg.googleusercontent.com/vi/zQEH6oSuJ5s/0.jpg>
<https://superuser.com/questions/43853/is-there-any-benefit-to-using-ipv6-on-my-home-network>
<https://i.ytimg.com/vi/XbF-MBr0Vlk/maxresdefault.jpg>
https://cdn-images-1.medium.com/max/1280/1*km7Jx9UaJRAxum9HIMp8nQ.png
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https://willheymarquise.files.wordpress.com/2017/02/img_7041.jpg
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<https://pixabay.com/en/persons-users-multiple-three-red-23875/>



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