Scaling to Large Clusters in EKS

Operational experience and challenges

Agenda

- Introduction
- Scaling Challenges
  1. Autoscaling
  2. Custom Network Interface (CNI)
  3. DNS
  4. API server
  5. Cost Optimization
- Vision
- Conclusion

Introduction

About Us

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About SmartNews

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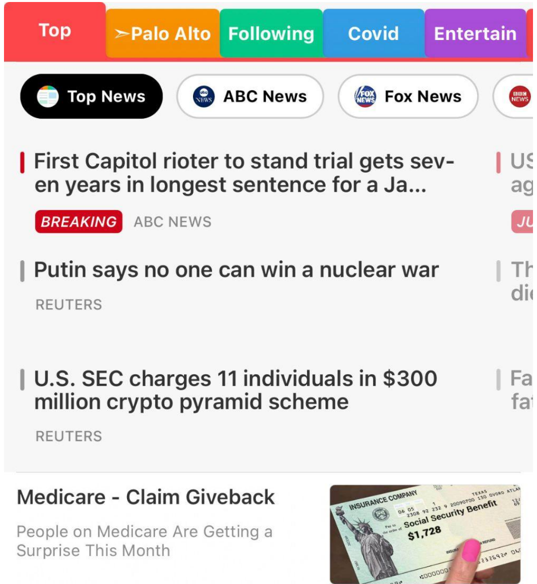

First Capitol rioter to stand trial gets seven years in longest sentence for a Ja...

BREAKING ABC NEWS

Putin says no one can win a nuclear war

REUTERS

U.S. SEC charges 11 individuals in $300 million crypto pyramid scheme

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Medicare - Claim Giveback

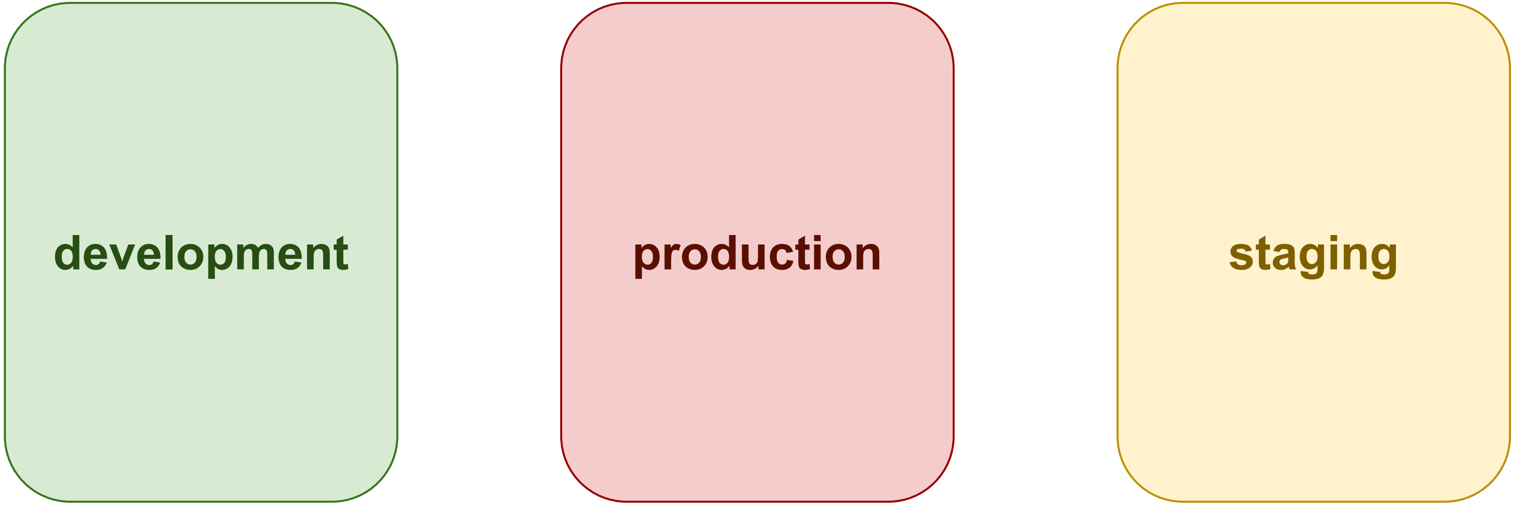
People on Medicare Are Getting a Surprise This Month

EKS Usage

- Started using EKS for smaller services from **July 2019**
- Most new services after around **Mid 2020** run on EKS
- From **February 2021** started to deploy stateful services
- Scaled up processing workloads around **End of 2021**

Cluster Topology

Environment



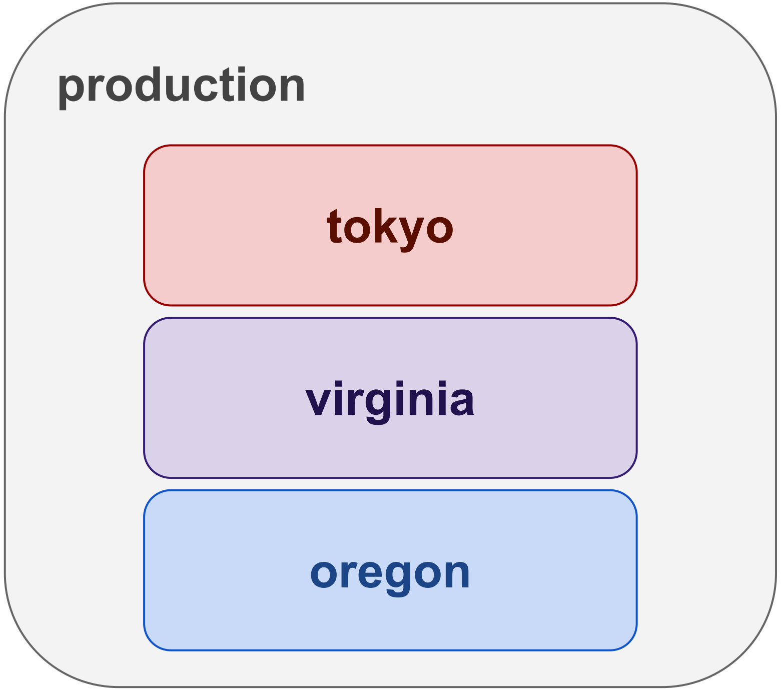
development

production

staging

Cluster Topology

Region



production

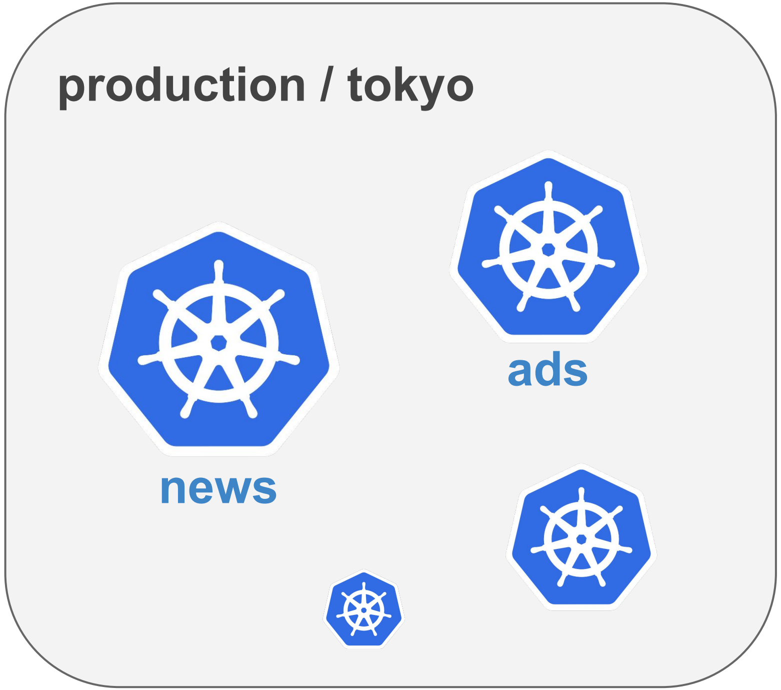
tokyo

virginia

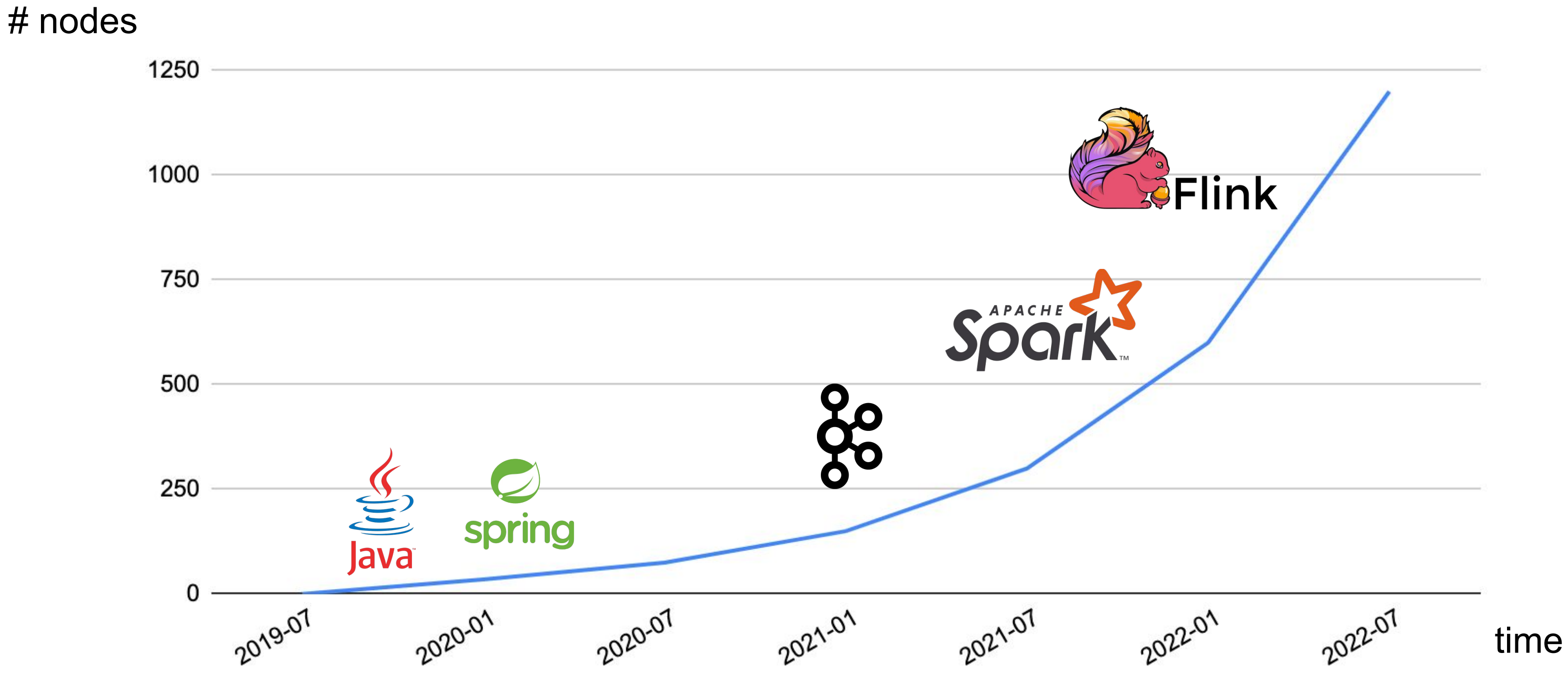
oregon

Cluster Topology

Cluster



Cluster Scale



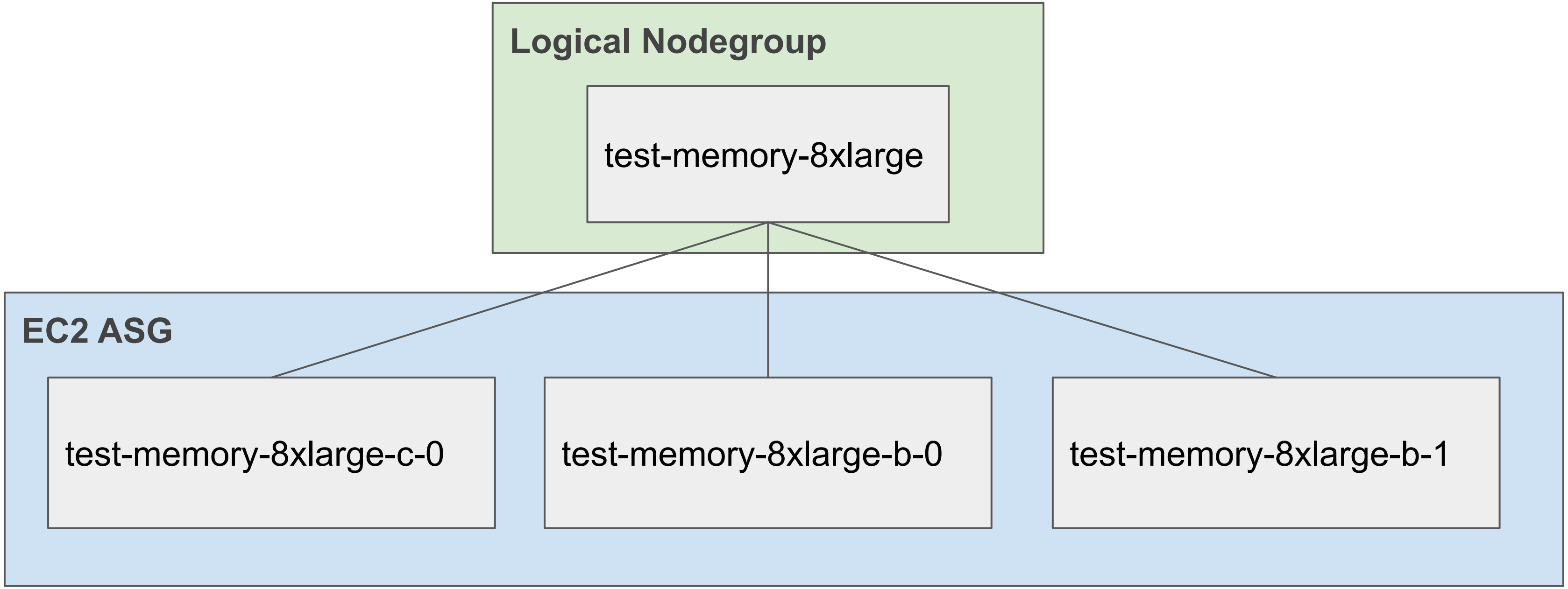
Scaling Challenges

#1 Autoscaling

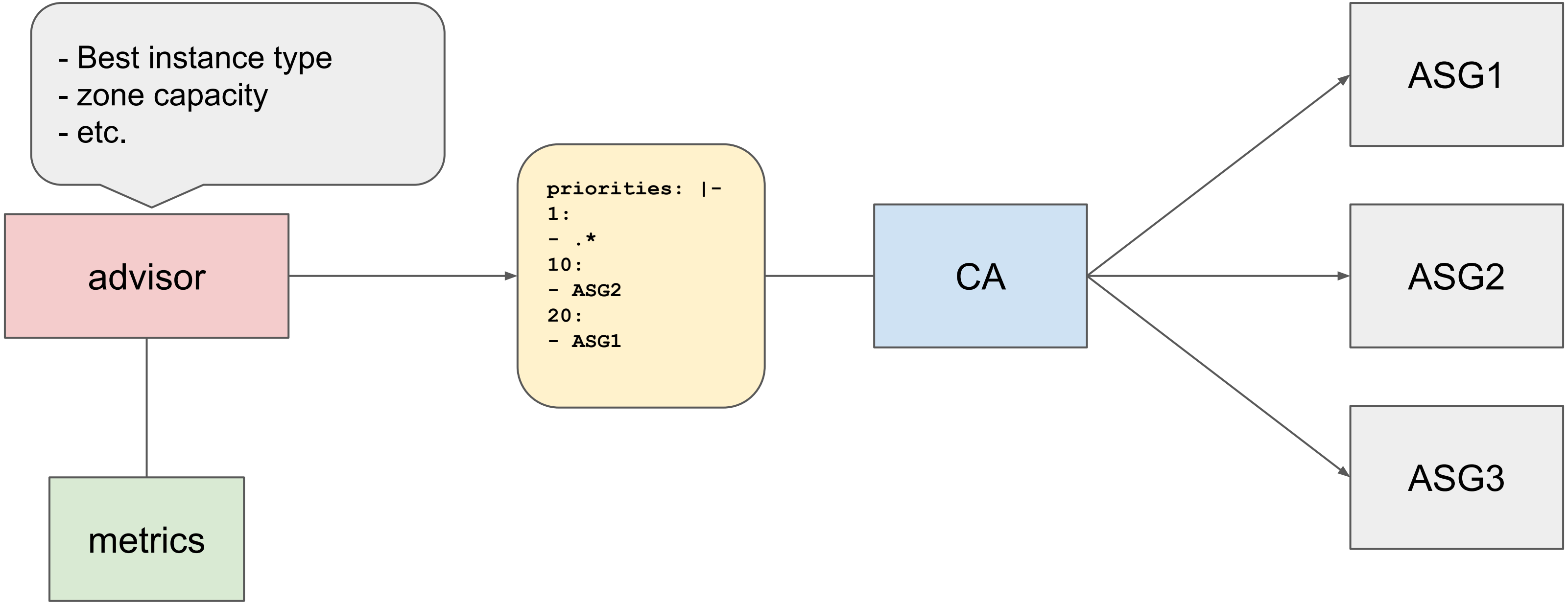
#1 Autoscaling

- Challenges
  - Large number of nodes
  - The load changes significantly during a day
- Solutions
  - Pod Autoscaling: Keda
    - Cron scaler
    - Cloudwatch scaler
  - Node Autoscaling: Cluster Autoscaler

Node Autoscaling



Dynamic Priority



```
priorities: |-
1:
- .*
10:
- ASG2
20:
- ASG1
```

#2 Custom Network Interface

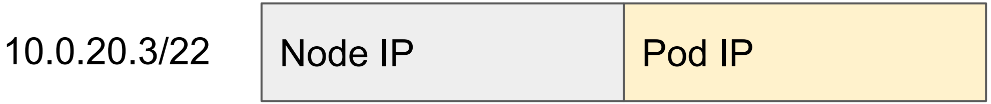
#2 AWS-CNI

- Challenges
  - Pod failed to start due to IP assignment failure
  - *InsufficientFreeAddressesInSubnet: The specified subnet does not have enough free addresses to satisfy the request.*
  - *RequestLimitExceeded: Request limit exceeded*
- Solutions
  - Understand its source code
  - Use custom network: *AWS_VPC_K8S_CNI_CUSTOM_NETWORK_CFG*
  - Use prefix delegation: *ENABLE_PREFIX_DELEGATION*

Insufficient IP

Before

- aws-cni tries to get IP from the same subnet of the node
- cluster autoscaler doesn’t know that, it will try to add more nodes if there are available IP when scaling up



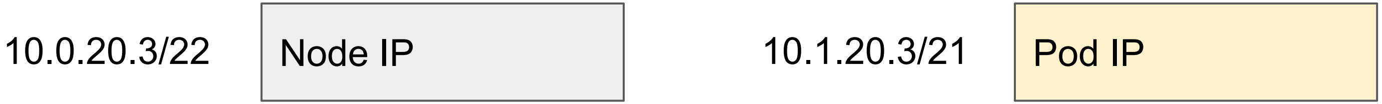
10.0.20.3/22

Node IP

Pod IP

Now

- separated node and pod subnets



10.0.20.3/22

Node IP

10.1.20.3/21

Pod IP

Prefix Delegation

aws-cni applies for new IP when warm target isn’t satisfied and releases when there are too much

If pods are frequently scheduled and deleted on the same node, aws-cni would make many requests to AWS API to get IP.

By using prefix, it applies for one subnet(/28) instead of one IP

```
func (c *IPAMContext) datastorePrefixTargetState() (short int,
enabled bool) {
        …
        freePrefixesInStore := c.dataStore.GetFreePrefixes()
        toAllocate := max(c.warmPrefixTarget-freePrefixesInStore,
0)      log.Debugf("Prefix target is %d, short of %d prefixes, free
%d prefixes", c.warmPrefixTarget, toAllocate, freePrefixesInStore)
        return toAllocate, true
 }
```

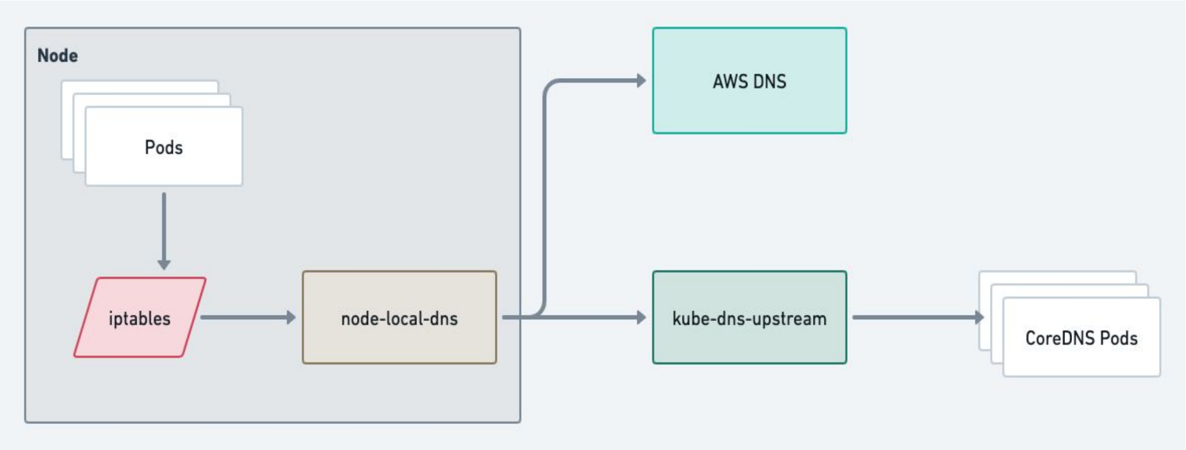
#3 DNS

#3 DNS

- Challenges
  - High latency
  - AWS API limit
- Solutions
  - NodeLocal DNS cache
  - Increase TTL of external domains

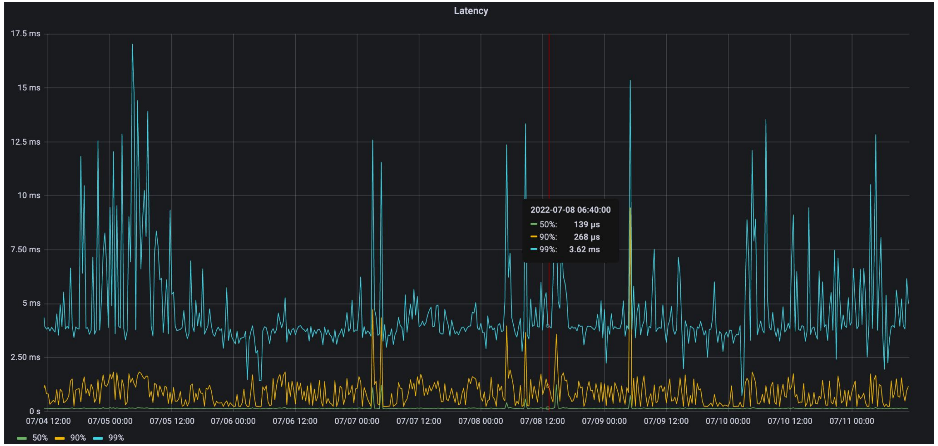
Local DNS cache

```
cluster.local:53 {
        errors
        cache {
                success 9984 60
                denial 9984 5
        }
        reload
        loop
        bind 169.254.20.10 10.100.0.10
        forward . __PILLAR__CLUSTER__DNS__ {
                force_tcp
        }
        prometheus :9253
        health 169.254.20.10:8080
        }
.:53 {
        errors
        cache 300
        reload
        loop
        bind 169.254.20.10 10.100.0.10
        forward . /etc/resolv.conf
        prometheus :9253
}
```

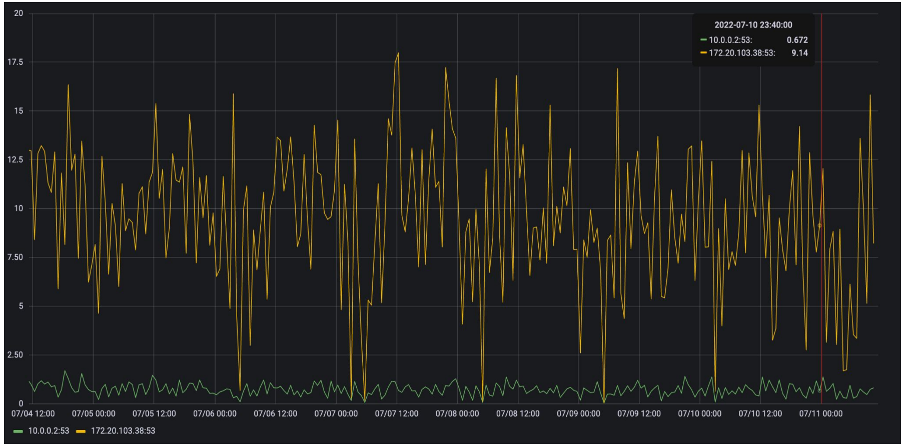


DNS Improvement

Latency



Requests

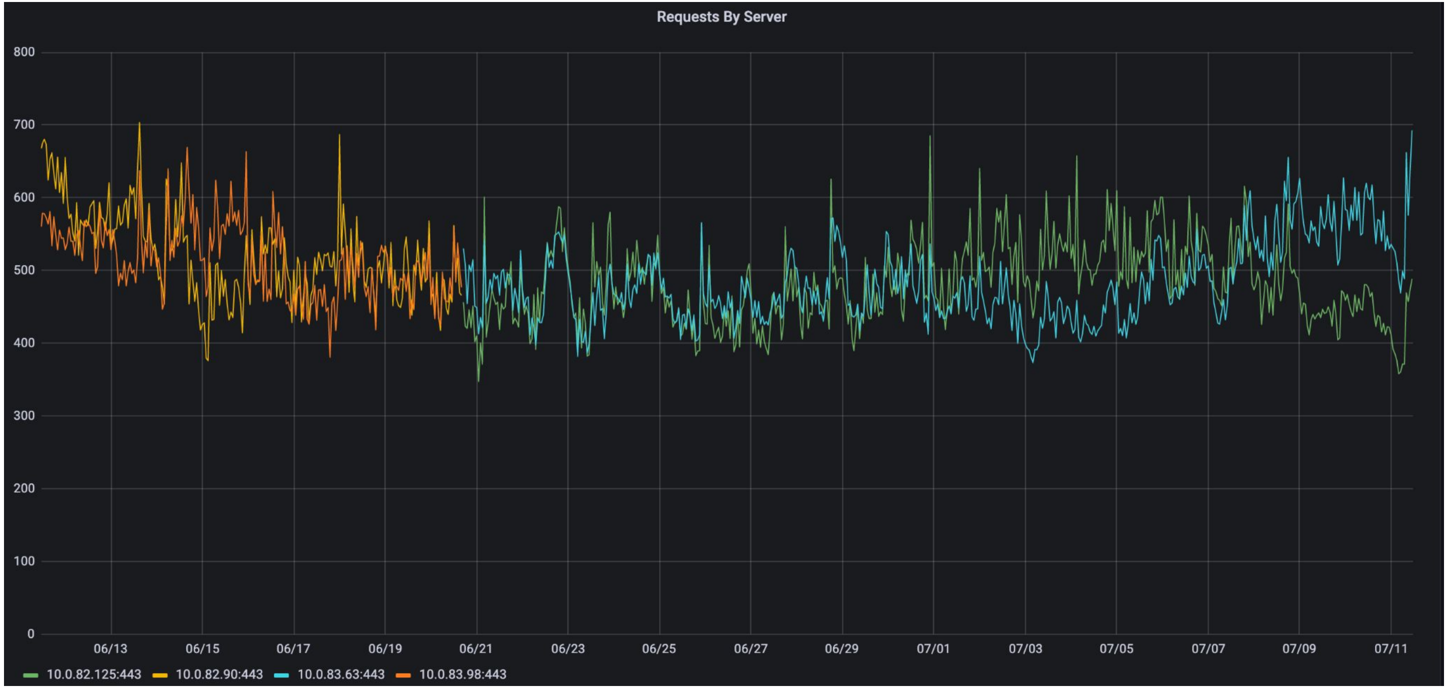


#4 API server

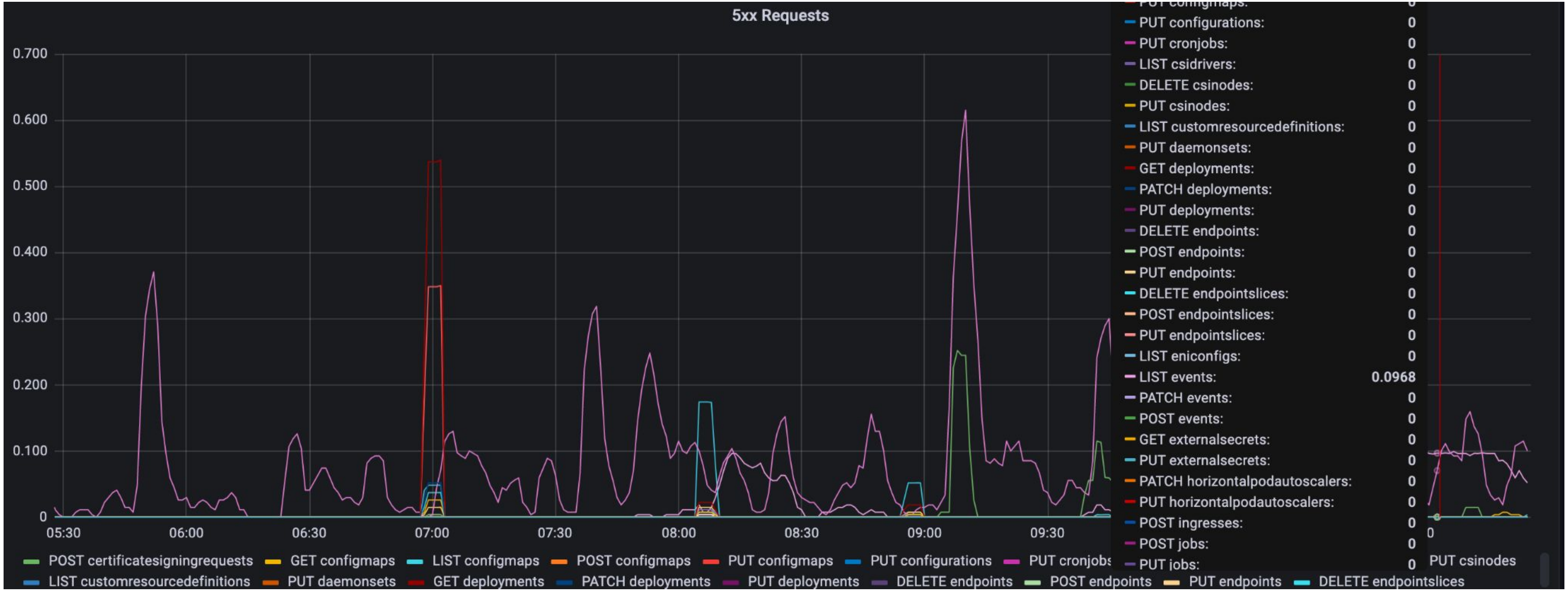
#4 API server

- Challenges
  - Outages
  - Unable to access EKS API
  - High latency
- Solutions
  - Setup monitoring
  - (WIP) Setup proxy server

EKS Monitoring- QPS

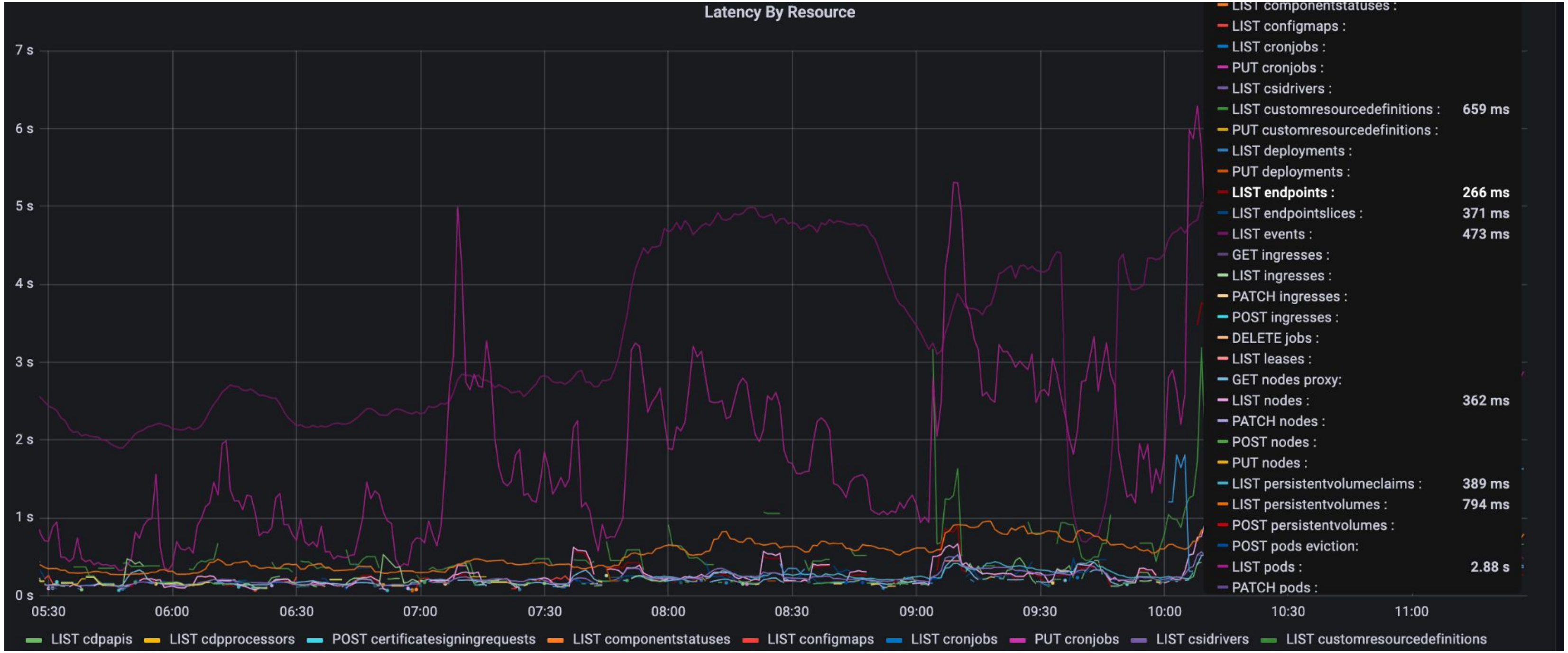


EKS Monitoring- 5xx



PUT configmaps:	0
PUT configurations:	0
PUT cronjobs:	0
LIST csidrivers:	0
DELETE csinodes:	0
PUT csinodes:	0
LIST customresourcedefinitions:	0
PUT daemonsets:	0
GET deployments:	0
PATCH deployments:	0
PUT deployments:	0
DELETE endpoints:	0
POST endpoints:	0
PUT endpoints:	0
DELETE endpointslices:	0
POST endpointslices:	0
PUT endpointslices:	0
LIST eniconfigs:	0
LIST events:	0.0968
PATCH events:	0
POST events:	0
GET externalsecrets:	0
PUT externalsecrets:	0
PATCH horizontalpodautoscalers:	0
PUT horizontalpodautoscalers:	0
POST ingresses:	0
POST jobs:	0
PUT jobs:	0

EKS Monitoring– latency



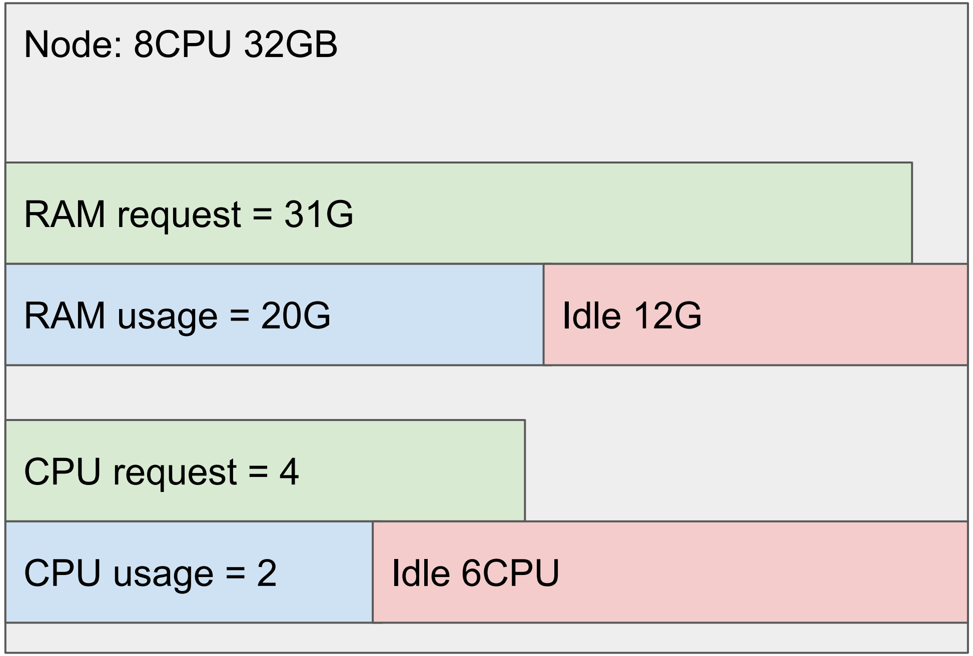
LIST componentstatuses :	
LIST configmaps :	
LIST cronjobs :	
PUT cronjobs :	
LIST csidrivers :	
LIST customresourcedefinitions :	659 ms
PUT customresourcedefinitions :	
LIST deployments :	
PUT deployments :	
LIST endpoints :	**266 ms**
LIST endpointslices :	371 ms
LIST events :	473 ms
GET ingresses :	
LIST ingresses :	
PATCH ingresses :	
POST ingresses :	
DELETE jobs :	
LIST leases :	
GET nodes proxy:	
LIST nodes :	362 ms
PATCH nodes :	
POST nodes :	
PUT nodes :	
LIST persistentvolumeclaims :	389 ms
LIST persistentvolumes :	794 ms
POST persistentvolumes :	
POST pods eviction:	
LIST pods :	2.88 s
PATCH pods :	

#5 Cost Optimization

#5 Cost Optimization

- Challenges
  - Cost increased significantly in last 6 month
- Solutions
  - Resource quota
  - Spot adoption
  - Resource utilization

Resource utilization



Node: 8CPU 32GB

RAM request = 31G

RAM usage = 20G

Idle 12G

CPU request = 4

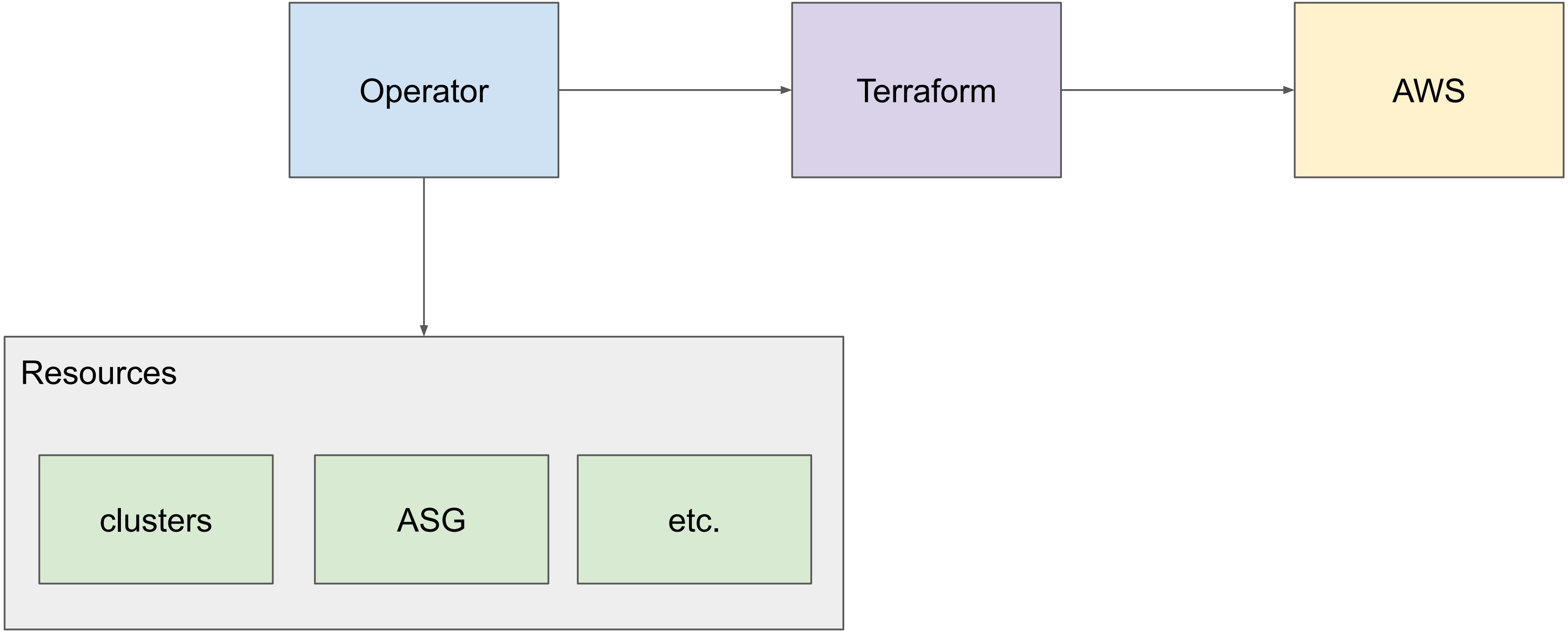
CPU usage = 2

Idle 6CPU

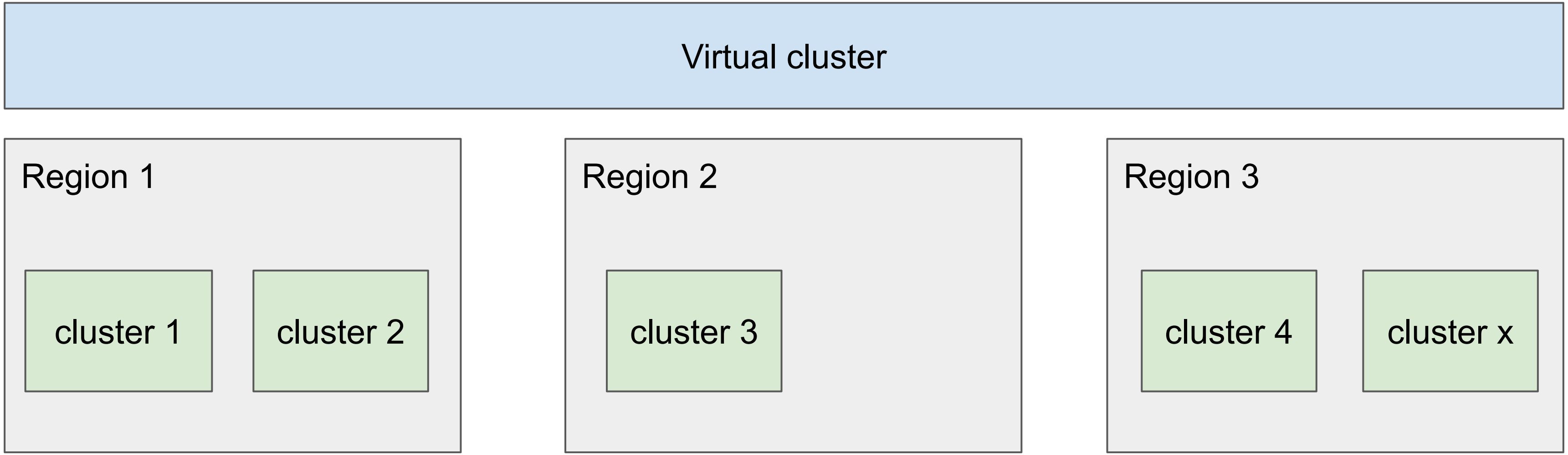
- Use Kubecost to identify low efficiency workloads
- CA dynamic priority

Vision

Cluster Operator



Virtual Cluster



Conclusion

Conclusion

- Prepare for a larger scale when providing new features
    - Especially for operators that work with the entire cluster
- Have a deep understanding of crucial components
    - Even on EKS you will run components (CNI, CA, etc) yourself
- Be cost sensitive all the time
    - Hard to manage node utilization and cross-AZ traffic