Kubernetes Performance and Best Practices

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Table of Content

- Deployment Strategies
- Resource Constraints
- Monitoring
- Volumes
- Labels
- Registry and Package Management

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Exposing Service and Load Balancing

Access Services – What's best for me ?

Internal access – it's easy

- curl http://$(kubectl get svc myservice --template='{{.spec.clusterIP}}'):8080/

External access – it's not easy

- **NodePort type** – services may clash due to same and limited number of ports
- **LoadBalancer type** –
  - Cloud: Use cloud provider load balancing, e.g. ELB in AWS. ELB instance is provisioned that proxies traffic for the Service inside the K8s cluster
  - Bare metal: DaemonSet running HAProxy -> watch services annotation through k8s API -> HAProxy config file re-written using pod IPs -> HAProxy exposes ports 80 and 443 and exposed to outside traffic as NodePorts

Traffic – public load balancer – forward traffic to nodeports – haproxy does host path resolution through service annotation – traffic routed to pod ip

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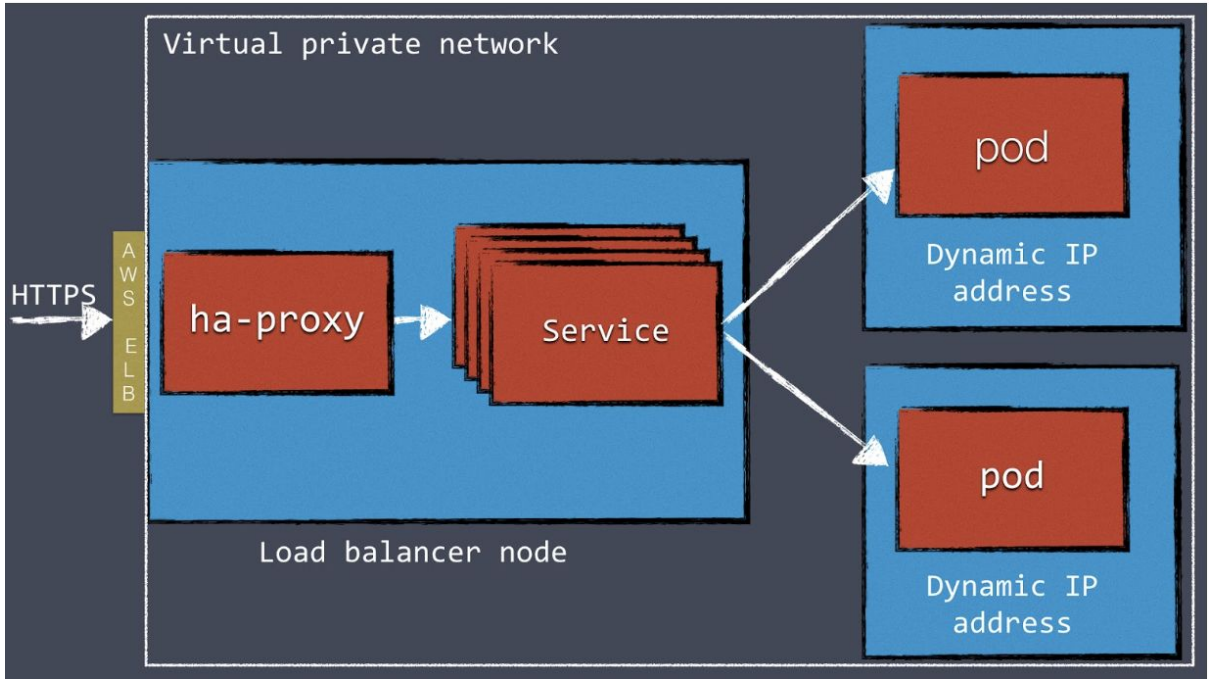
Two Step Load Balancing

Two step load balancing (in AWS)

- Configure a load balancer such as HAProxy or NGINX in front of the Kubernetes cluster.
- Use (for e.g.) AWS Elastic Load Balancer to route external web traffic to an internal HAProxy cluster.
- Can configure internal HAProxy with a “back end” for each Kubernetes service, which proxies traffic to individual pods.



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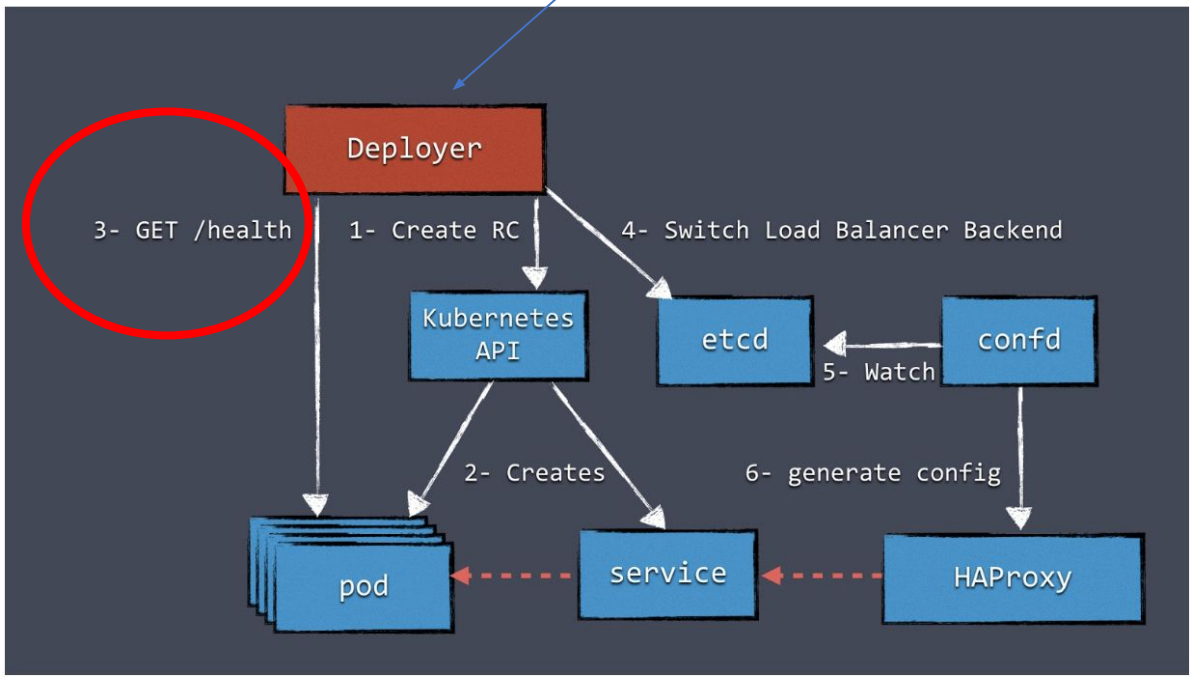
Deployment

Deployment – Blue/Green or Rolling Update

Health check

- Important aspect - health checking on pods before switching the load balancer.
- Implement Readiness and Liveness probes on pods
- Log events
- Deploy with {**--record**}

Deployer orchestrates the deployment.
Can be influenced by open source projects like
https://bitbucket.org/amdatulabs/amdatu-kubernetes-deployer/src/master/



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Proper Deployment Parameters

```
spec:
  replicas: 8
  revisionHistoryLimit: 5
  minReadySeconds: 20
  type: RollingUpdate
  strategy:
    rollingUpdate:
      maxUnavailable: 25%
      maxSurge: 2
```

Rolling Update parameters

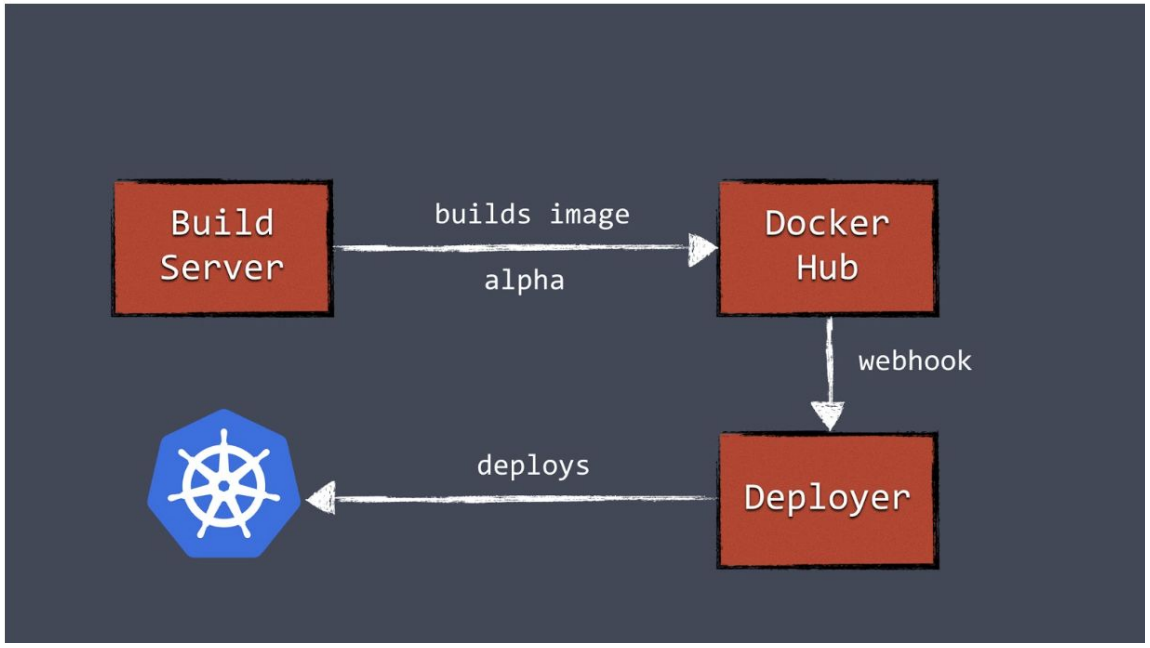
- At least **6** pods out of 8 (75%) are always running
- Prevents the expected number of replicas from being exceeded by more than **2** pods in order to avoid insufficient computing resources
- Pod is considered stable only after staying in the *Running* phase for at least **20** seconds so that late crashes, typically due to timeouts, can automatically pause the deployment

Default
25% availability – for huge production workload, app could become unresponsive.
25% Surge – when running tight on resources, this could bring you too close to limits

Making Deployments Automatic

Build Server

- Build server, after a successful build, push a new Docker image to a registry such as Docker Hub.
- Build server can invoke the Deployer to automatically deploy the new version to a test environment.



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Graceful Pod ShutDown

Pod killing process

- Send SIGTERM
- Wait (this wait period is a property of the **podSpec** that can be overridden)
- Sends SIGKILL

If you have anything you need to do to ensure graceful shutdown then you need to implement a handler for SIGTERM, otherwise the process will get killed immediately and removed from etcd

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Know your Resource Constraints

Resource Constraints – Extremely Important

- **Configure resource requests and CPU/memory limits on each pod**
- Can also control resource guarantees
- If you don’t constraint resources, containers may crash because they couldn't allocate enough memory

```
spec:
  resources:
    requests:
      cpu: 200m
      memory: 32Mi
    limits:
      cpu: 64m
      memory: 64Mi
```

Request – what a container is guaranteed to get

Limit – container never goes above this value

- CPU is defined in milli-cores and memory in bytes
- Memory limits – if a container passes its memory limit, it will be terminated
- CPU limits – if a CPU passes its CPU limits, k8s will throttle the container, but it won’t get killed

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Resource Constraints

The world is not ideal !! People may define the resource and forget OR set a very high limit.

- Define ResourceQuota and LimitRange
- Lock down namespace using quotas – e.g. no quota on prod and very strict on dev namespace

```
spec:
  hard:
    requests.cpu: 500m
    requests.memory: 100Mib
    limits.cpu: 700m
    limits.memory: 500Mib
```

ResourceQuota
Aggregated for all containers

```
limits:
- default:
    cpu: 600m
    memory: 100Mib
min: …
max: …
```

LimitRange
Range for a single container

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Properly Monitored and Logged K8s Cluster

Centralized Logging and Monitoring

- Monitoring and logging is crucial in this new dynamic environment
- Logging into a server to look a log file doesn't work anymore - large number of replicas and nodes
- Plan to ***build centralized logging and monitoring***

Options for Logging

Graylog, EFK – log management

Kafka – to collect and digest logs from containers

… lot others

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Monitoring – Application Specific

Kubernetes does an excellent job of recovering when there's an error.

Kubernetes recovery works so well that containers may crash multiple times a day because of a memory leak, without anyone noticing it.

* Nice to have – **application-specific health checks and dashboards** that monitors nodes and pods

- Measure load, throughput, application errors, and other stats

Options for Monitoring

InfluxDB, Heapster, cAdvisor, Grafana

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Configuration Management

- *Loosely coupled*
  - Keep config and code (image) separated, so config can be persisted even when containers are restarted, scaled up, scheduled to new nodes, etc.
    - Use ConfigMaps, Secrets, and Environment variables for configuration storage
    - Prefer using CM and secrets than environment variables – no access control, these are global variables, and few process like Cron & Monit may scrub environment variables

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Labels

A simple and powerful way to associate related entities

- Use plenty of descriptive labels
- Use labels to perform operations, node selection, deployments
- Use labels to monitor the cluster – Build label specific metrics – to identify performance of entities at a {TYPE} level
    - Metrics at Pod and container level might not be too useful, instead visualize for a group of pods using labels

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Registries and Packages

- Use secured registries
  - Do not trust arbitrary base images
  - Signed & secured image
  - No {latest} tag
  - Have team specific base images, yet keep base image small
- Use Helm
  - Templates to define, install and upgrades k8s based application
  - Helps in streamlining CI/CD
- Docker
  - Non-root user
  - One process per container
  - Crash cleanly with an error message

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Pod Scheduling and Others

- **There is a limit on number pods you can run per node**

Default is 110 per node, change this in kubelet setting

https://kubernetes.io/docs/reference/command-line-tools-reference/kubelet/

(--max-pods)

- **Inotify errors**

Scheduling more pods may give inotify errors (filesystem monitoring watchers)

Change this in all host. Either use Infra as code tools or run a container as a Daemon set to change these limits in all host

e.g. https://gist.github.com/brendan-rius/5ac9ec3dd7e196222c8b8b356f8973d2

Pod Scheduling and Others

- **Set CPU and Memory Limits asap**

As discussed before

Scenario:- A containers using 200Mib memory but only 5% of a vCPU. Running xxx of these containers might end up scheduling lots in a node, resulting in OOM errors. K8s will eventually figure out, as OOM will evict pods and re-schedule, but this process may take time

- **Pod Isolation**

Critical pods should be isolated by node affinity and anti-affinity

Reliability and Agility At Scale

https://www.youtube.com/watch?v=9C6YeyyUUmI

https://github.com/kubernetes-retired/contrib/tree/master/scale-demo

Follow 12 factor

https://12factor.net