CLOUDERA

Apache YuniKorn: preemption for multi tenant Kubernetes clusters

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YUNIKORN

AGENDA

Introduction YuniKorn

Kubernetes priority and preemption

Preemption in YuniKorn

Architecture - Deep Dive

Demo

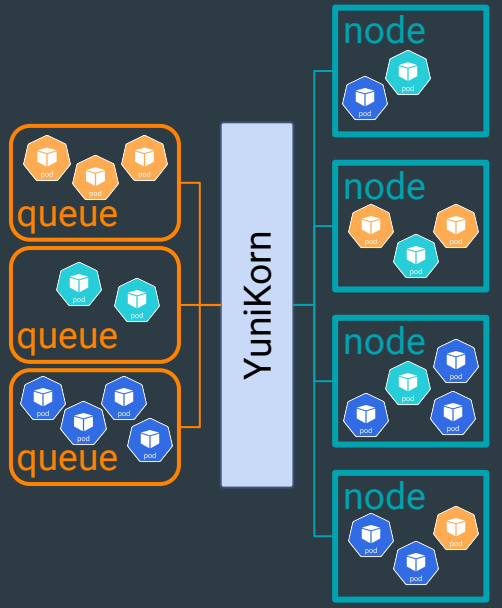
Q & A

APACHE YUNIKORN

Introduction

YuniKorn capabilities:

- Diverse workloads
  - Services (long running)
  - Batch (short running and or recurring)
- Fast scheduling decisions
- Multi-tenancy
- Multiple deployment modes
  - Standalone
  - Plugin for K8s default scheduler



Workload Queueing

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KUBERNETES PREEMPTION AND PRIORITY

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Preemption and priority limitations

Priority definition and use:

- PriorityClass defines name and value
- Cluster-wide definitions
- Scheduling: priority sort only, one cluster wide queue
- Any rogue user can create a pod with the highest defined priority

Preemption:

- Scheduling opt-in: use preemption to make space for this pod?
- Priority ranking only
- Opt-out from getting preempted by scheduler is NOT possible

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BATCH WORKLOADS

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Why is preemption mission critical?

Static Queues

- Fixed distribution of all available resources
- Guaranteed to always have the resources
- Caveat: under-utilization of resources over time

Elastic Queues

- Oversubscription of available resources
- "Borrow" resources when not used by other queues
- Caveat: could starve other queues

Preemption can rebalance resources across queues

BATCH WORKLOADS

Why is preemption mission critical?

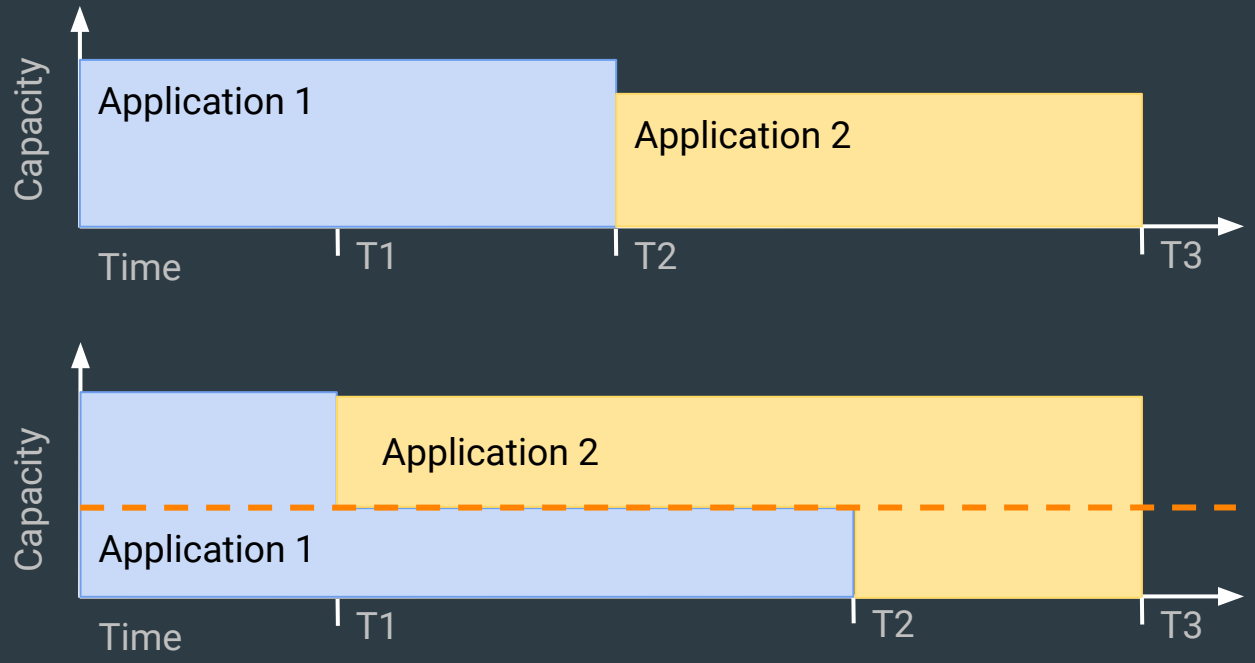
No preemption

Queue1

Queue2

Guaranteed

With preemption



PREEMPTION - YUNIKORN

High-level overview

Queue resource config:

- Maximum: never more than this hard limit
- Guaranteed: amount always available for this queue
- Set and enforced at each level in the hierarchy

Preemption

- Adjust queue usage towards guaranteed resources
- Hierarchy aware
- Application aware

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LAWS OF PREEMPTION

The lesson learned from YARN

Before design and implementation: describe behaviour

1. Preemption policies are strong suggestions, NOT guarantees
2. Preemption can never leave a queue lower than its guaranteed capacity
3. A task cannot preempt other tasks in the same application
4. A task cannot trigger preemption unless its queue is under its guaranteed capacity
5. A task cannot be preempted unless its queue is over its guaranteed capacity
6. A task can only preempt a task with lower or equal priority
7. A task cannot preempt tasks outside its preemption fence (one-way constraint)

PREEMPTION SUPPORT

Design

YuniKorn preemption design

- Leverage existing K8s priority class object
- Integrated with the queue hierarchy
- Guaranteed resources configurable per queue
- Extended features:
  - Application aware: originator pod
  - Allow pods to request not to be preempted
  - Preemption delay
  - Fencing of queues in hierarchy
  - Priority offset

PREEMPTION SUPPORT

K8s Configuration

Annotated K8s PriorityClass

- YuniKorn preemption policy
- Allow preemption
  - opt-in: true
  - opt-out: false

- the policy is a strong suggestion, NOT guarantee
- pods which opt-out will be considered last for preemption

```
apiVersion: scheduling.k8s.io/v1
kind: PriorityClass
metadata:
  name: high-priority
  annotations:
    yunikorn.apache.org/allow-preemption: "true"
value: 1000
globalDefault: false
```

PREEMPTION SUPPORT

Queue configuration

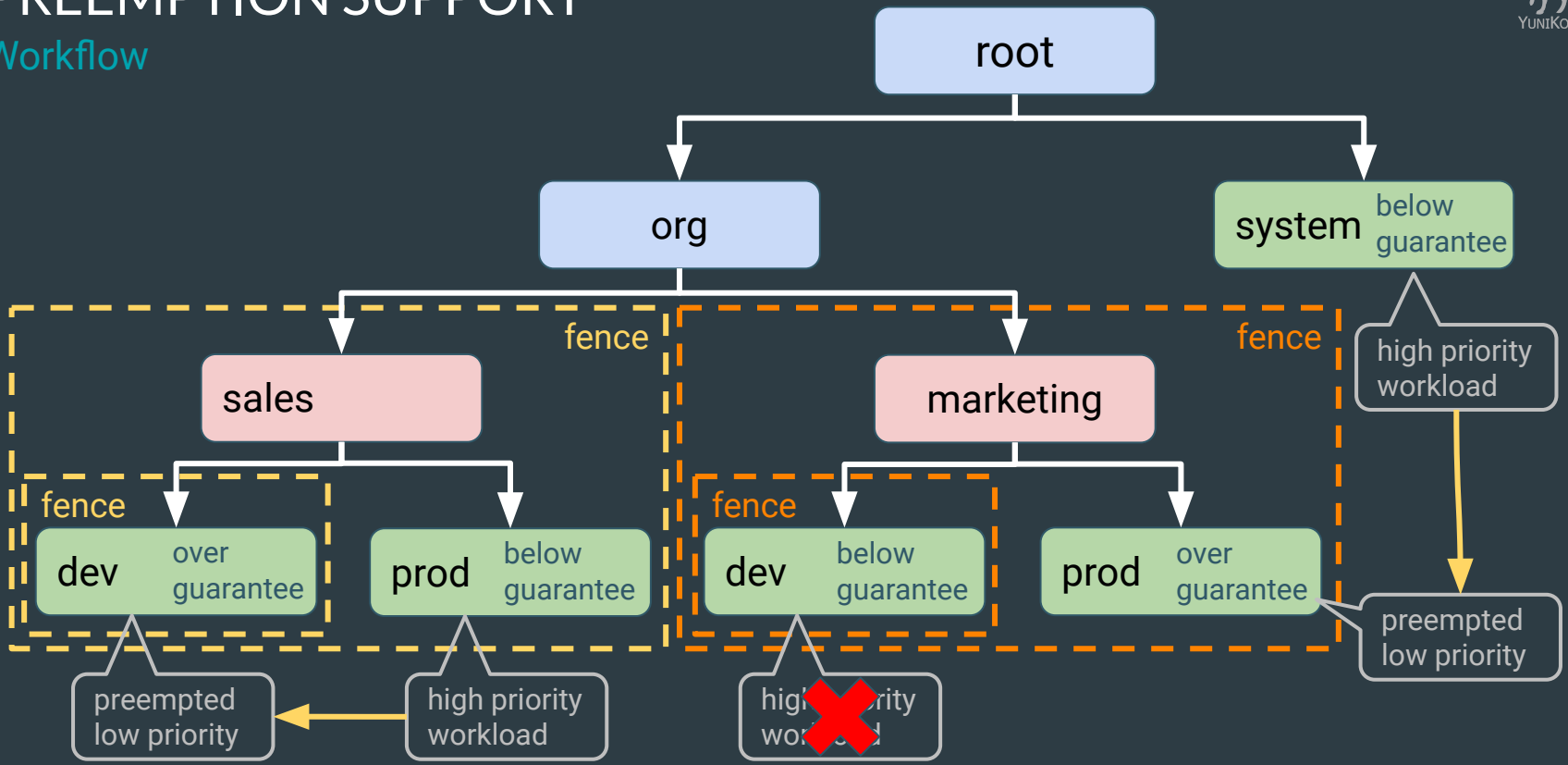
Queue properties

- Guaranteed resources
  - Threshold for preemption
  - Preemption goal
- Preemption Fence
  - Queue scoped
  - Limit preemption to child queues
- Preemption Delay
  - Delays preemption to allow normal scheduling to place the request
  - Default: 30 seconds

```
queues:
- name: sales-ops
  parent: false
  resources:
    guaranteed:
      {memory: 24Gi, vcore: 6}
    max:
      {memory: 32Gi, vcore: 8}
  properties:
      preemption.policy: fence
      preemption.delay: 30s
      priority.policy: fence
      priority.offset: "1000"
```

PREEMPTION SUPPORT

Workflow



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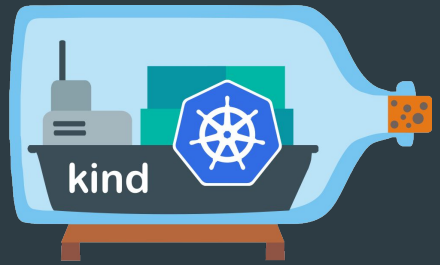
DEMO

Prepared cluster

- Showing two pieces of functionality
  - Quotas
  - Preemption

- Kind cluster (1.28.0)
  - Plugin version deployed
  - 3 nodes (control-plane + 2 workers)
  - Hierarchical queues:
    - Complex structure defined (multi layer)
    - Different guaranteed resources
    - Fencing at different levels



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THANK YOU

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