SIG-Scheduling Deep Dive

Da Ma (Huawei, @k82cn)

Wei Huang (IBM, @Huang-Wei)

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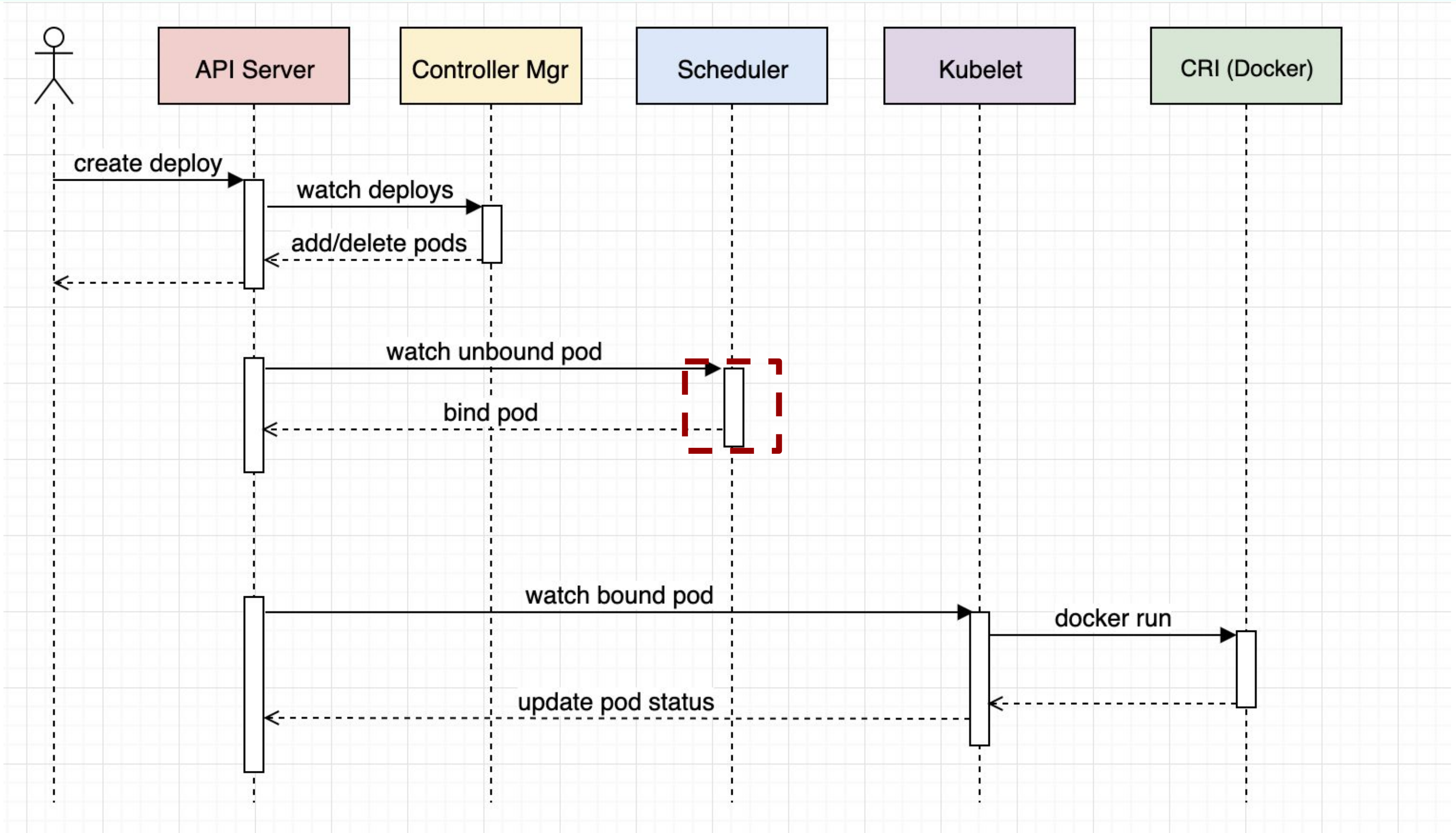
Scheduler Overview

Scope of Scheduler



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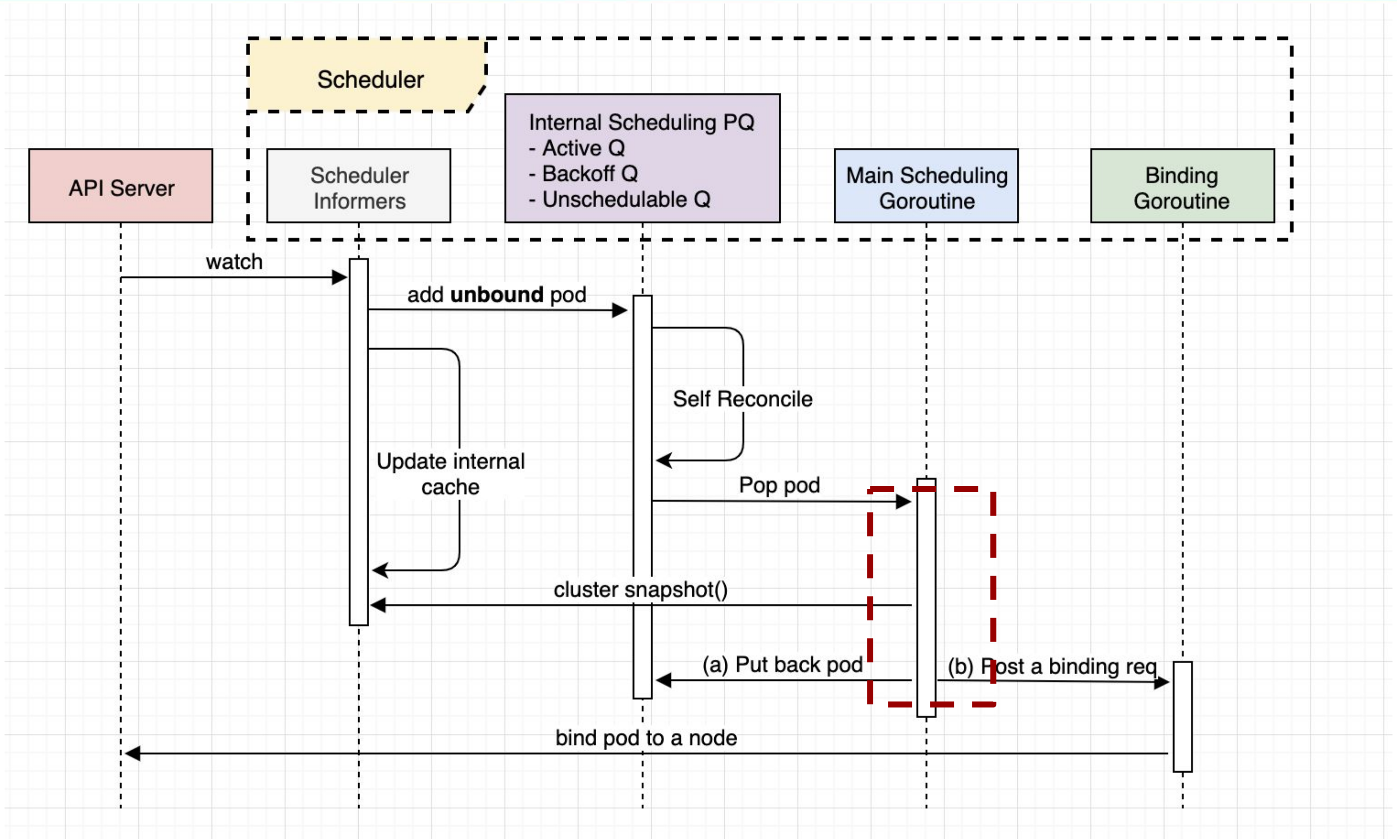
Detailed Scheduling Flow



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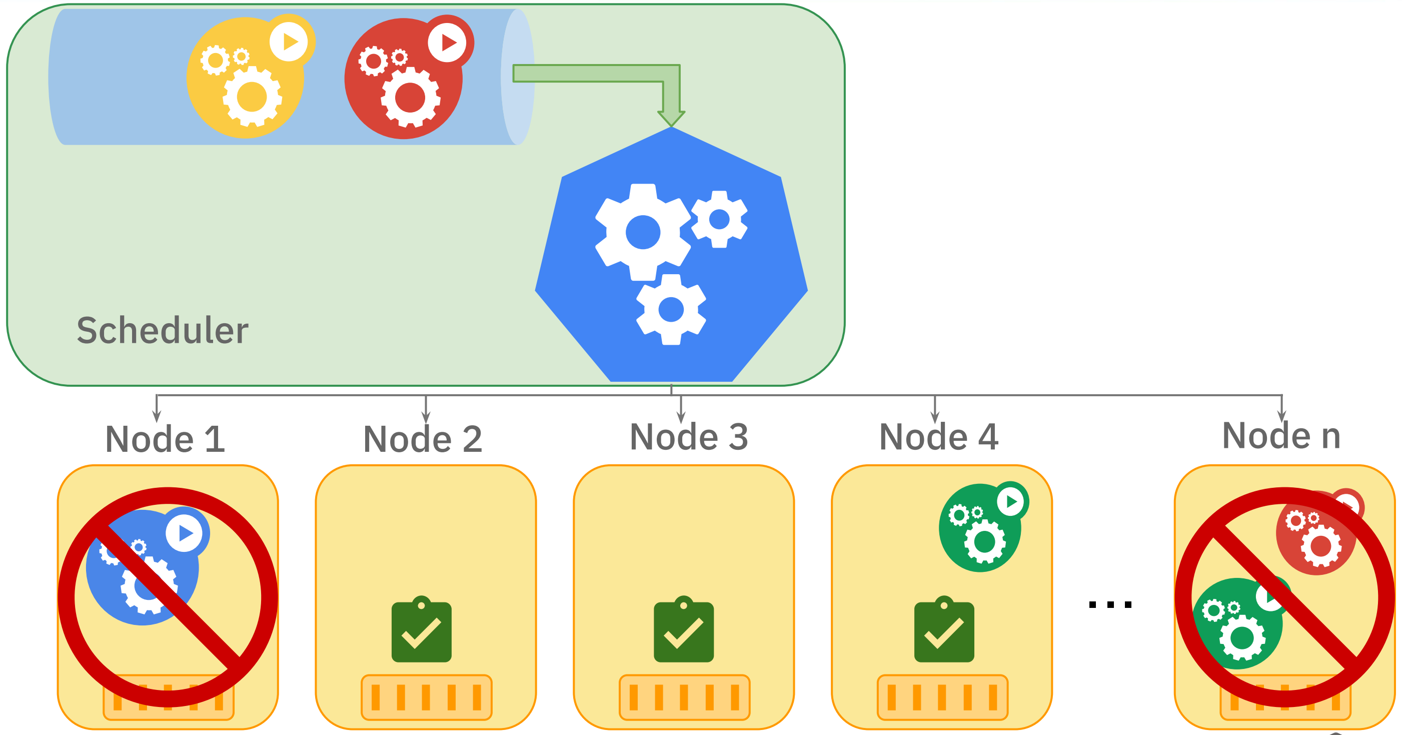
Predicates - filter out nodes



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Predicates

For incoming pod, gives a **YES** or **NO** answer whether it fits on a node or not

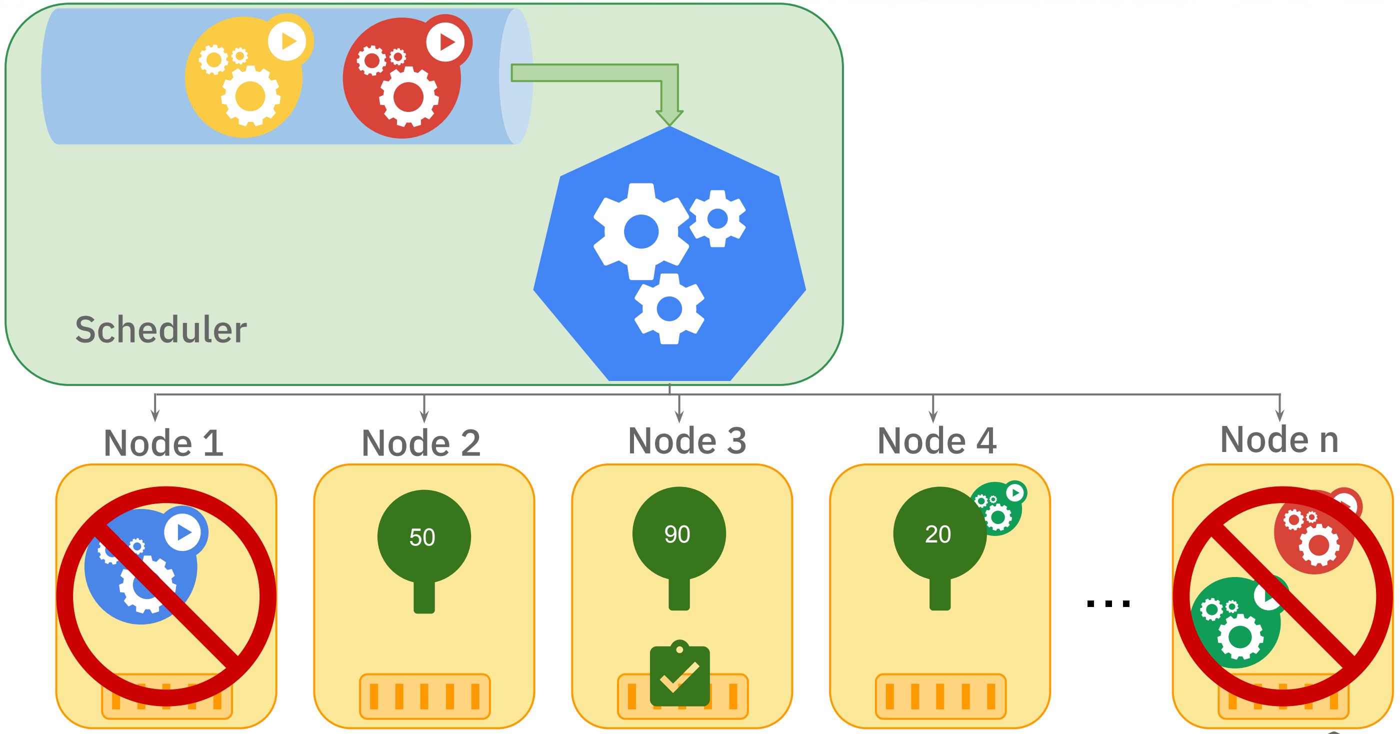
```
For each node, check if the node fits the incoming pod (running in
Parallel)
    For each sorted predicate: (running in batch)
        Run the predicate function:
            If succeeded, continue to next predicate
            If failed, record fail reason, break [1]
        If failure can be resolved by Preepmtion, proceed with Preemption
    Aggregate fail reason(s), and return if it's a fit
Filter out failed nodes, and get a node list that fits for incoming node
```

[1] Prior to 1.10, the behavior is continue to next predicate. Starting 1.10, the default behavior was optimized to "break" the predicates loop (see PR 56926). And it's configurable by parameter "AlwaysCheckAllPredicates" - which is useful for debugging.

Preemption (in Predicates phase)

```
When a pod can't be scheduled, starts to preempt: (blue == dry-run operation)
For each node, delete pods which has lower priority. Based on this state, check:
  If incoming pod cannot be scheduled, return;
  If incoming pod can be scheduled:
    For each pod with lower priority than incoming pod, start with higher one:
      Add the pod. Check:
        If incoming pod can still be placed, keep current pod. Continue
        If not, remove current pod, and add current pod to a "candidates" list
    Return the "candidates" list
If len(candidates) !=0, pick a node which a series of candidate victims belong to,
and talk to APIServer to "reserve" that node (set NominatedNode) for incoming pod,
then delete the candidate victims.
```

Priorities - rank the remaining nodes



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Priorities

For incoming pod, give a score (0~10) on each *filtered* node after Predicates phase. Each priority is defaulted weight 1.

Implemented using map/reduce pattern.

```
For each filtered node:
    For each priority:
        Calculate a score, then multiple its weight
    Final score for current node = sum(score * weight)
Get a final score list on all nodes
Pick up the node which has highest final score.
```

Design Rationale of Scheduler

1. The scheduler is **NOT** responsible for managing life cycle of Pods.
2. The minimum scheduling unit is **POD** (tried EquivalenceCache, but not good as supposed to be)
3. Schedule **one pod** at a time (scheduler can have multiple replicas, but only one leader is running)
4. **Best Fit** vs. First Fit
5. **Predicates** and **Priorities**
6. **Configurable** (schedule config file)
7. **Plugable** (new scheduler framework, scheduler extender, multiple schedulers)

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Recent Developments

Default Scheduler

Performance improvements

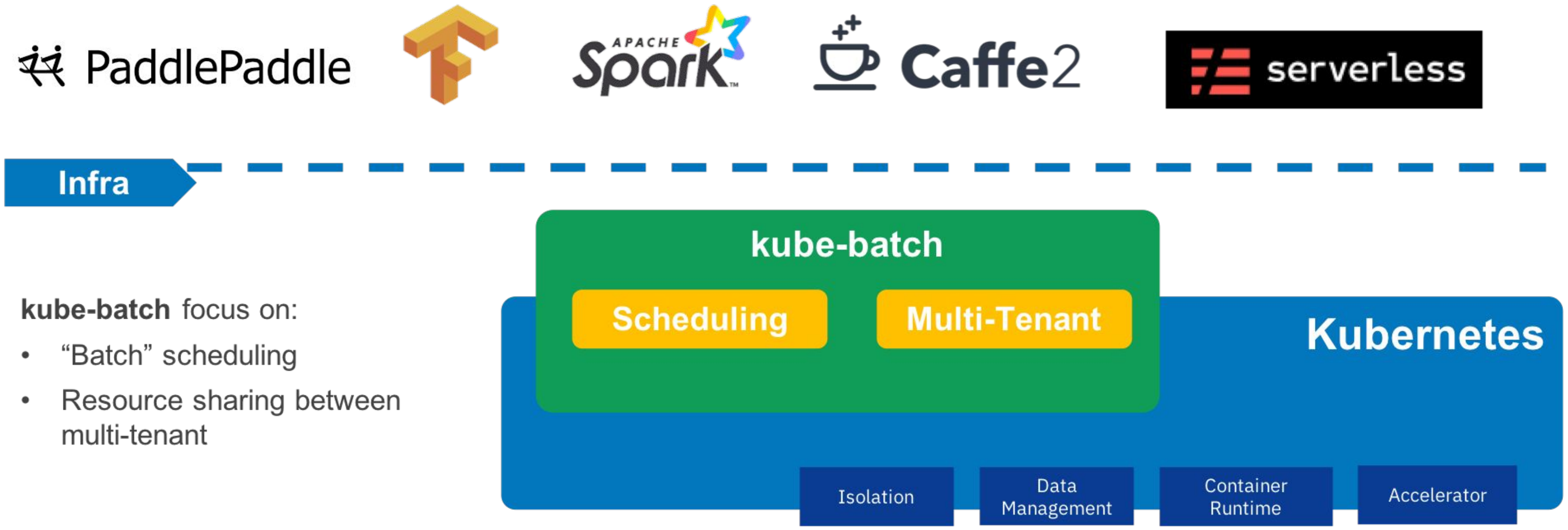
GA: Priority and Preemption

Planned features

- Even Pod Spreading
- Scheduler Framework

2019 KubeCon EU Deep Dive by Bobby Salamat - https://youtu.be/t189URLpG8E

Overview of kube-batch



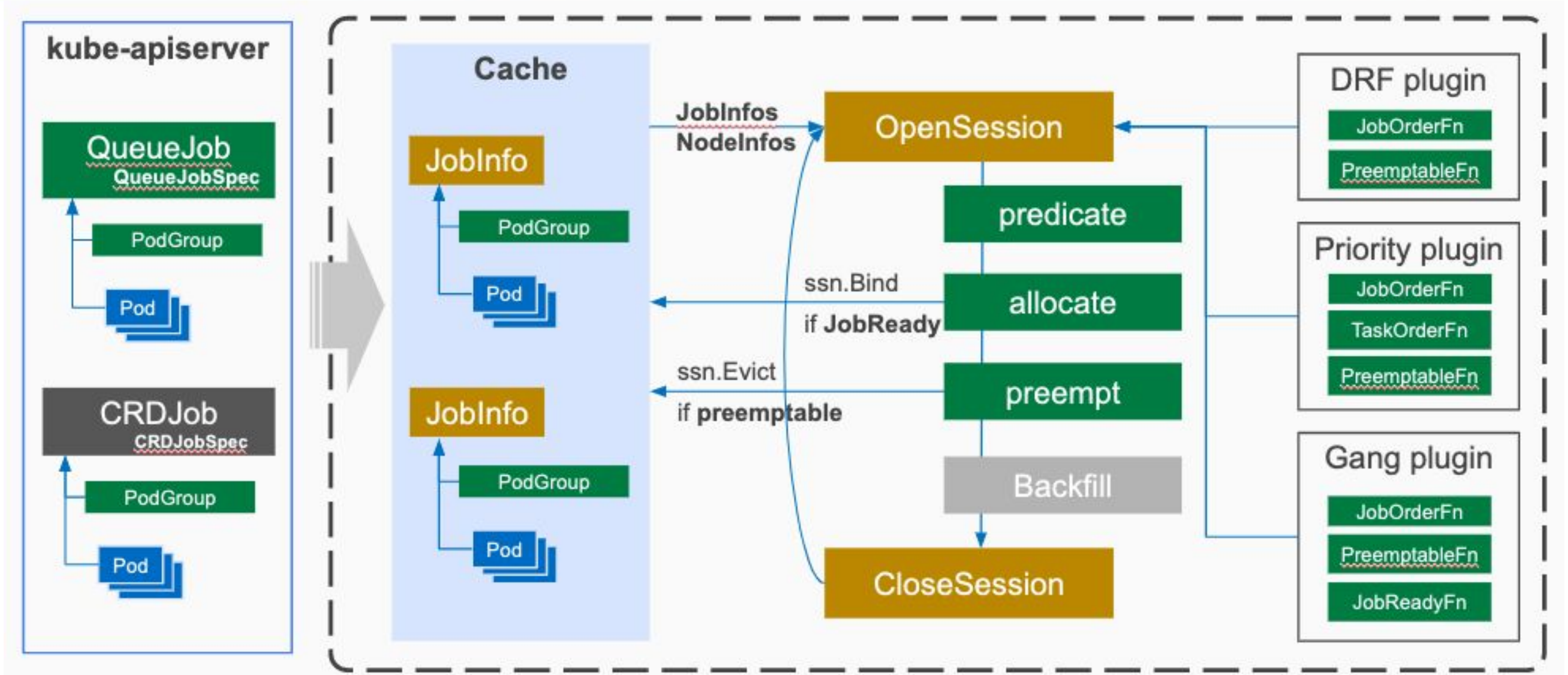
kube-batch focus on:

- "Batch" scheduling
- Resource sharing between multi-tenant

kube-batch **NOT** support:

- Data Management
- Accelerator (Kubelet), e.g. GPU
- Isolation for multi-tenant
- Job Management
- New container runtime, e.g. Singularity, CharlieCloud

Overview of kube-batch (cont.)



Re-construct JobInfo in Cache by **PodGroup**

Predicate, *allocate*, *preempt* are **Actions**, and they're **pluggable**

Plugins on demand

Features of kube-batch

- Co-scheduling
- “Fair-sharing” (job/queue)
- Preemption/Reclaim
- Task Priority within Job
- Predicates
- Queue
- Backfill (partially)
- Dynamic configuration

Batch Capability into Kubernetes (#68357)

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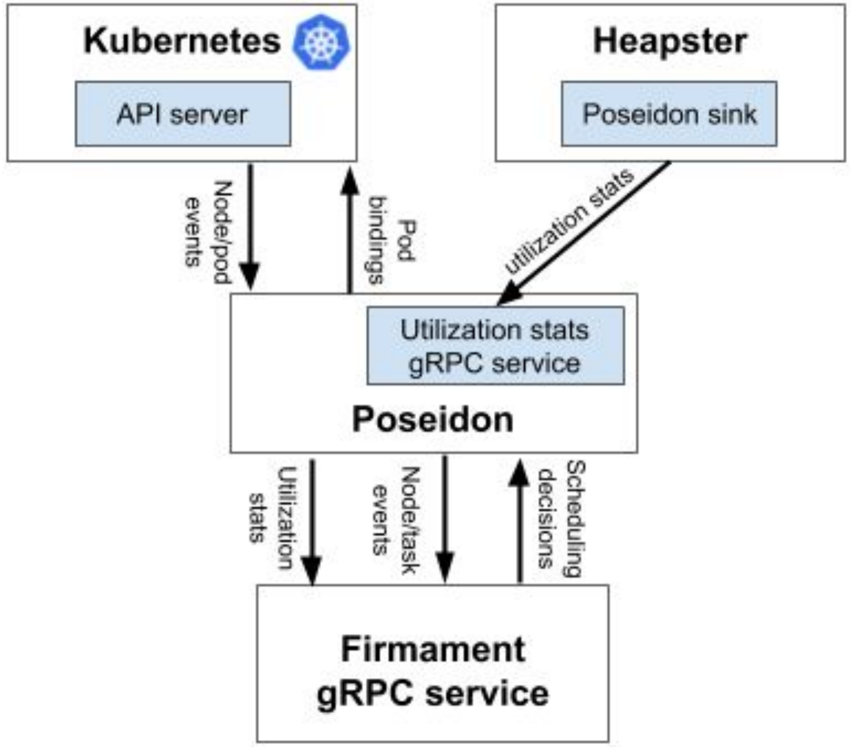
Poseidon



Poseidon/Firmament scheduler augments the current Kubernetes scheduling capabilities by incorporating a new novel flow network graph based scheduling capabilities alongside the default Kubernetes Scheduler.

Firmament models workloads on a cluster as flow networks and runs min-cost flow optimizations over these networks to make scheduling decisions.

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Features of Poseidon

1. Node level Affinity and Anti-Affinity
2. Pod level Affinity and Anti-Affinity
3. Taints & Tolerations
4. Gang Scheduling

How those schedulers **work together ???**

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Sorry, I don-t know :(

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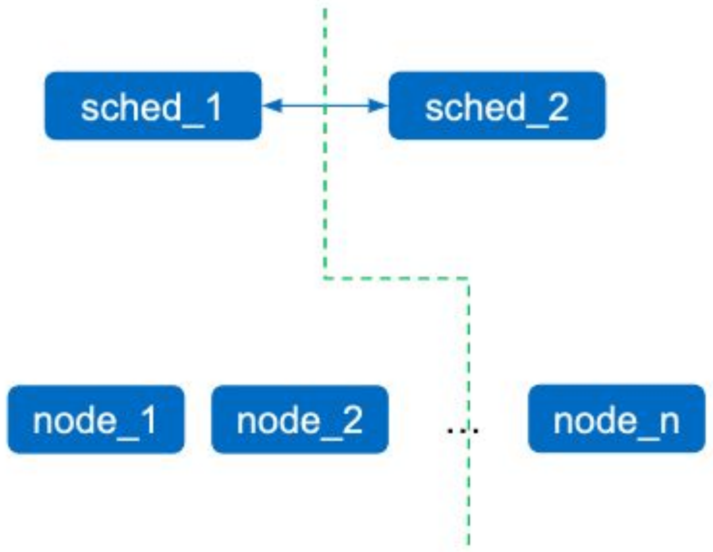
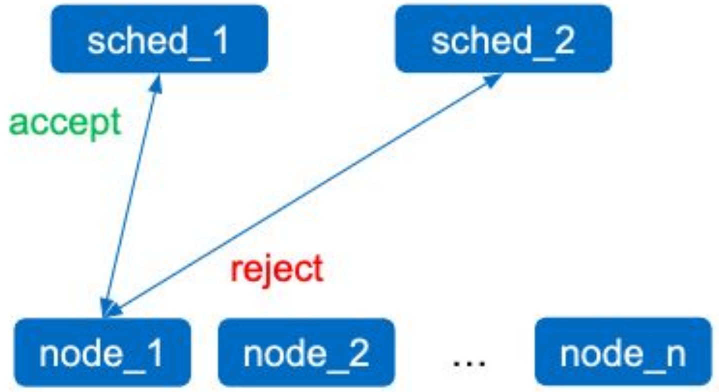
Multi-Schedulers

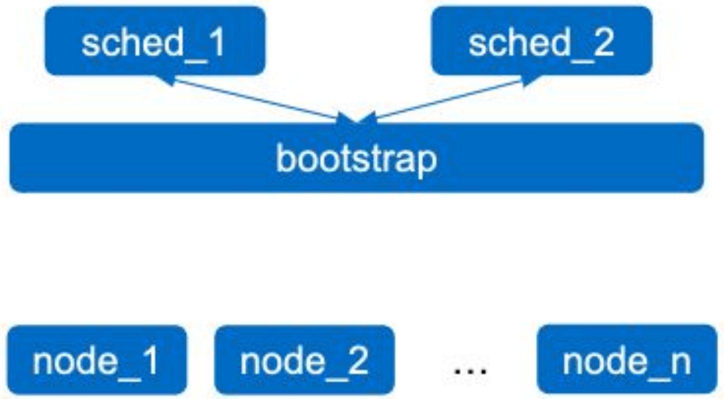


Option 1

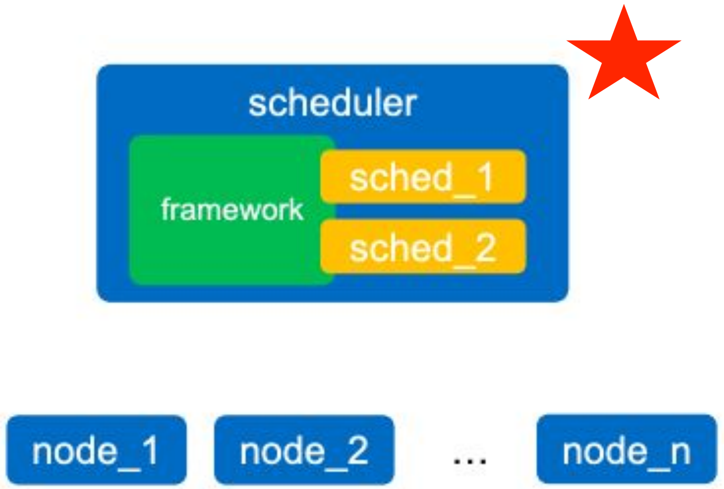


Option 2

Multi-Schedulers



Option 3



Option 4

Descheduler

Trigger Of Pod Movement/Migration

Eviction -> Creation -> Re-schedule

User Cases of Descheduler

- Some nodes are under or over utilized.
- The original scheduling decision does not hold true any more, as taints or labels are added to or removed from nodes, pod/node affinity requirements are not satisfied any more.
- Some nodes failed and their pods moved to other nodes.
- New nodes are added to clusters.

Policy & Strategy

- RemoveDuplicates
- LowNodeUtilization
- RemovePodsViolatingInterPodAntiAffinity
- RemovePodsViolatingNodeAffinity

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Pod Eviction Restriction

- Critical pods (with annotations scheduler.alpha.kubernetes.io/critical-pod) are never evicted.
- Pods (static or mirrored pods or stand alone pods) not part of an RC, RS, Deployment or Jobs are never evicted because these pods won't be recreated.
- Pods associated with DaemonSets are never evicted.
- Pods with local storage are never evicted.
- Best efforts pods are evicted before Burstable and Guaranteed pods.
- Pod are never evicted If violates its PDB

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Contact Us

Contact Us

Chairs

- @bsalamat
- @k82cn

Home page: https://github.com/kubernetes/community/tree/master/sig-scheduling

Slack channel: https://kubernetes.slack.com/messages/sig-scheduling

Mail list: https://kubernetes.slack.com/messages/sig-scheduling

Google doc:
https://docs.google.com/document/d/13mwye7nvrmV11q9_Eg77z-1w3X7Q1GTbslpml4J7F3A/view

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Thanks!

Q & A