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通过 Volcano 增强的智能基础设施优化LLM工作流程

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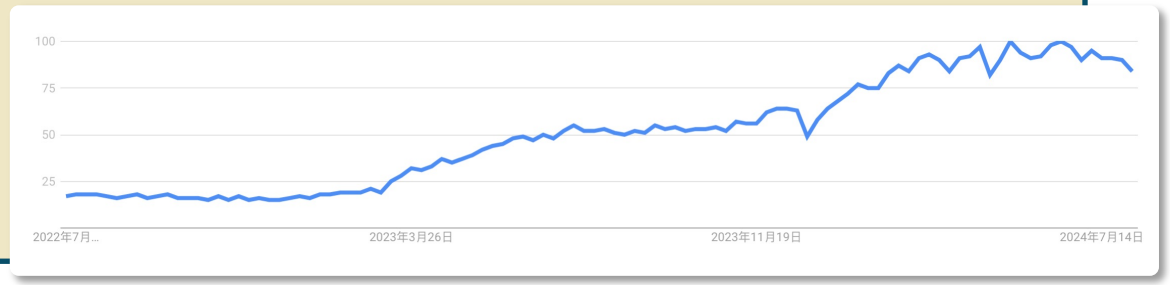
目录

背景

LLM关键词趋势

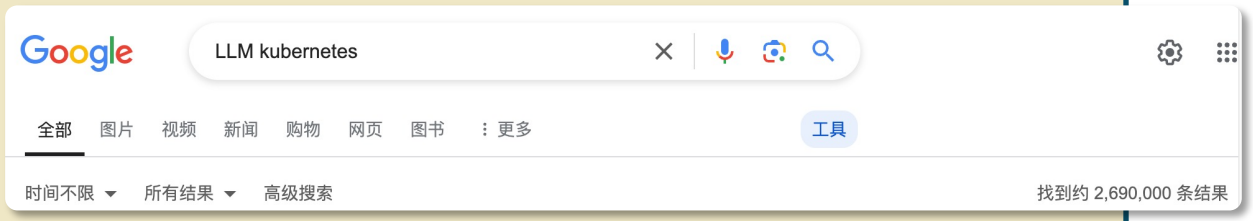


OpenAI博客文章

Scaling Kubernetes to 2,500 nodes 2018

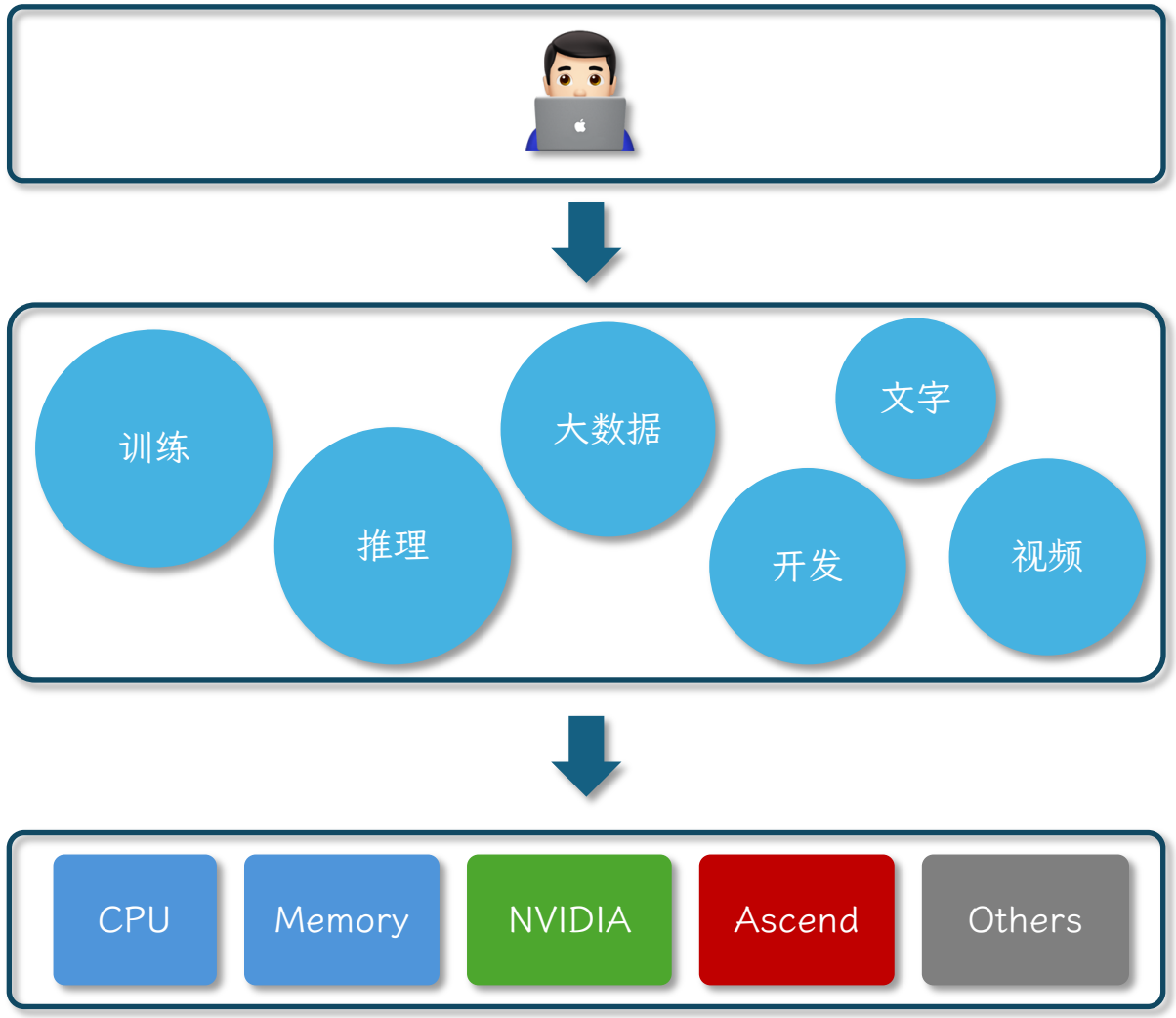
Scaling Kubernetes to 7,500 nodes 2021

Google搜索结果



- 从 2023 年开始，LLM 受到的关注越来越多
- 使用 Kubernetes 的 LLM 基础设施越来越多
- kubernetes 对于 LLM 的支持越来越好

现状



x3000

x6000/月

x1000

- 3000+不同部门用户，6000+任务每月
- 10+集群，1000+节点
- 任务类型复杂性。训练，推理，开发。
- 资源：单任务1-200实例，单实例CPU：1c-200c，GPU：1-8，内存20G-2T
- 功能：ssh免密，pod间打通
- 运行：所有实例同时调度
- 运行时长复杂性。时计天计月计共存。
- 计算资源复杂性。CPU，GPU，NPU等
- 网络环境复杂性。以太网、IB，RoCE

存在问题

故障

效率

易用性

故障

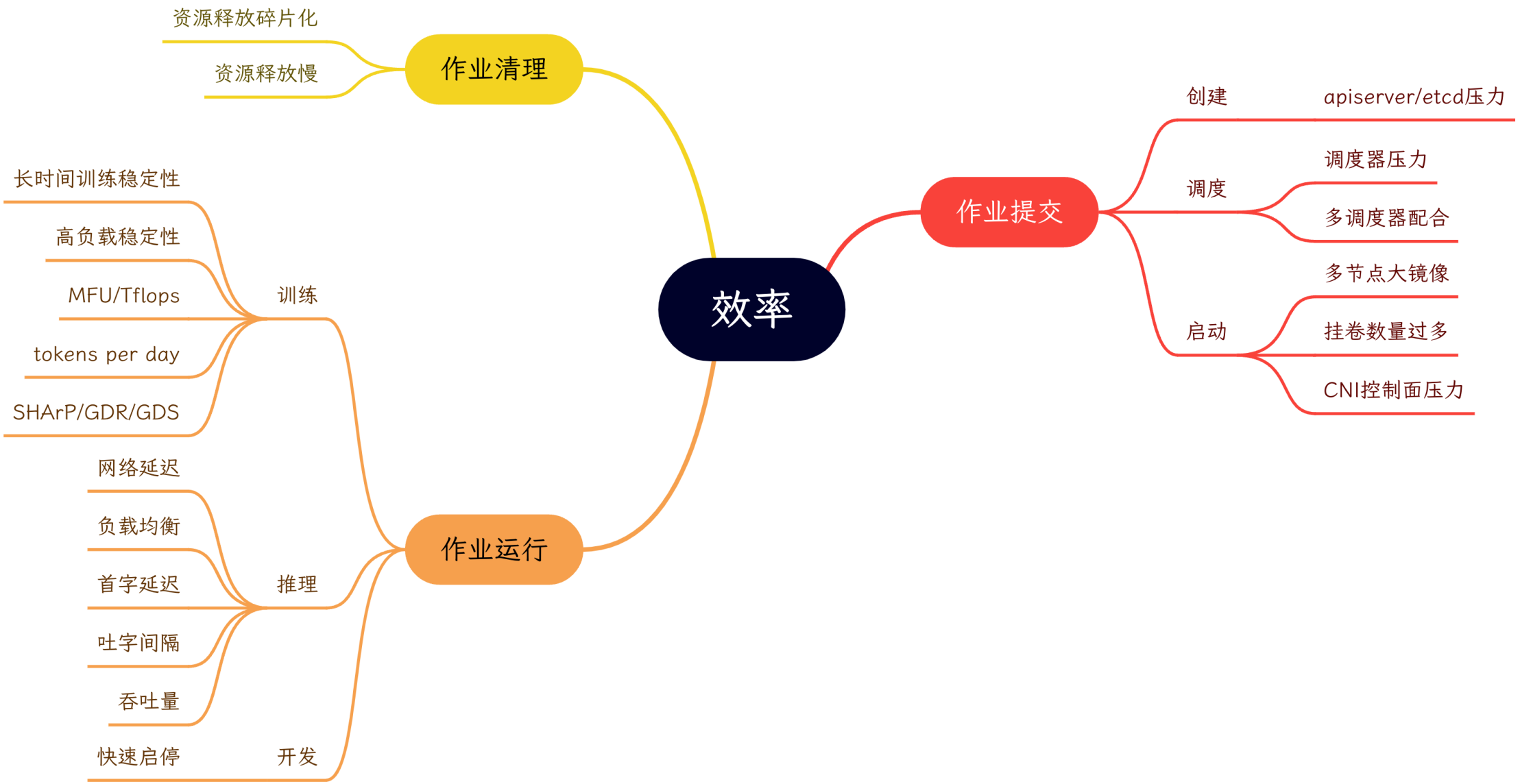
- 掉卡
- ECC 错误
- 显卡故障
- 网卡故障
- 机房掉电
- 误操作
- NAS异常
- 集群故障
- NVLINK故障
- P2P故障
- 散热故障
- ……

The Llama 3 Herd of Models

During a 54-day snapshot period of pre-training, we experienced a total of 466 job interruptions. Of these, 47 were planned interruptions due to automated maintenance operations such as firmware upgrades or operator-initiated operations like configuration or dataset updates. The remaining 419 were unexpected interruptions, which are classified in Table 5. Approximately 78% of the unexpected interruptions are attributed to confirmed hardware issues, such as GPU or host component failures, or suspected hardware-related issues like silent data corruption and unplanned individual host maintenance events. GPU issues are the largest category, accounting for 58.7% of all unexpected issues. Despite the large number of failures, significant manual intervention was required only three times during this period, with the rest of issues handled by automation.

https://ai.meta.com/research/publications/the-llama-3-herd-of-models/

效率


效率
作业清理
资源释放碎片化
资源释放慢
作业运行
训练
长时间训练稳定性
高负载稳定性
MFU/Tflops
tokens per day
SHArP/GDR/GDS
推理
网络延迟
负载均衡
首字延迟
吐字间隔
吞吐量
开发
快速启停
作业提交
创建
apiserver/etcd压力
调度
调度器压力
多调度器配合
启动
多节点大镜像
挂卷数量过多
CNI控制面压力

易用性

开发过程

- 巨量数据传输
- 环境依赖
- 环境保存
- 多种 IDE 集成
- tensorboard，
- grafana
- 可观测性优化

调度策略优化

- 多部门资源分配
- 独占资源/公共资源
- 任务抢占
- 任务排队
- gang调度策略
- binpack调度策略

多种任务类型

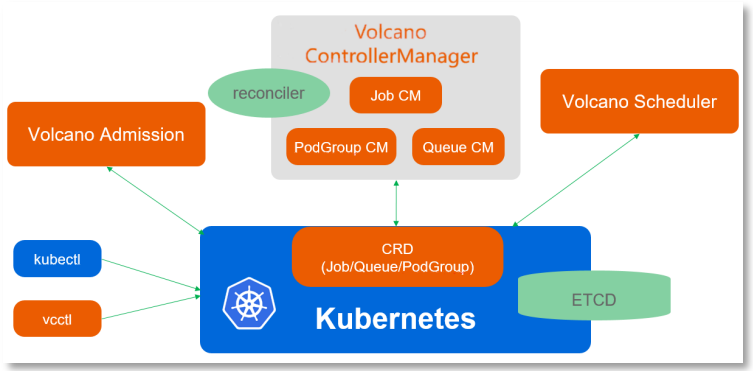
- Megatron-LM
- DeepSpeed
- opensora
- 分布式训练任务
- LLM 任务
- 多模态任务
- 数据处理

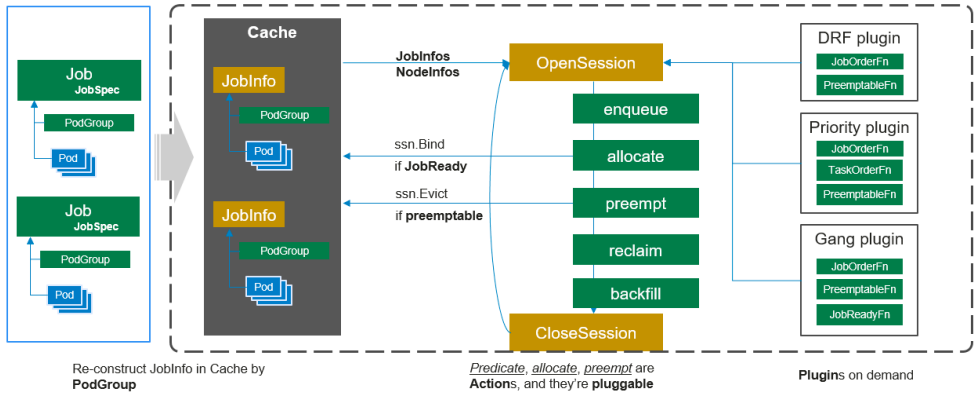
多种硬件

- 单机单卡，单机多卡，多机多卡任务
- NVIDIA
- Ascend
- 纯 CPU 任务
- RoCE/IB
- GPU 切分

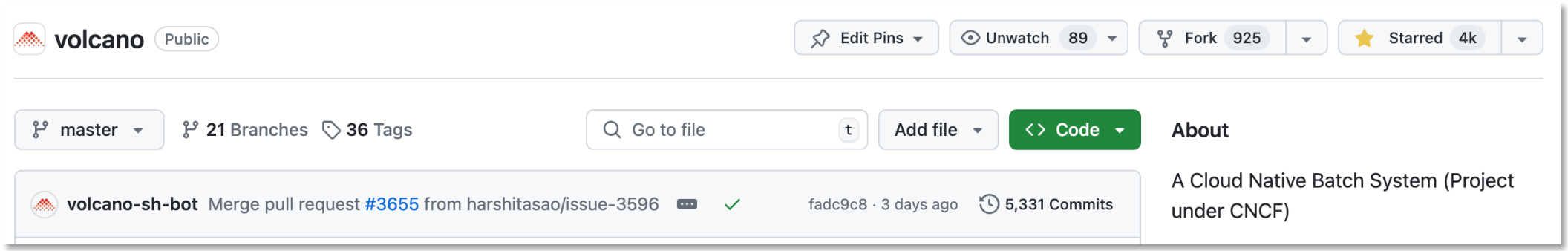
如何解决

Volcano介绍



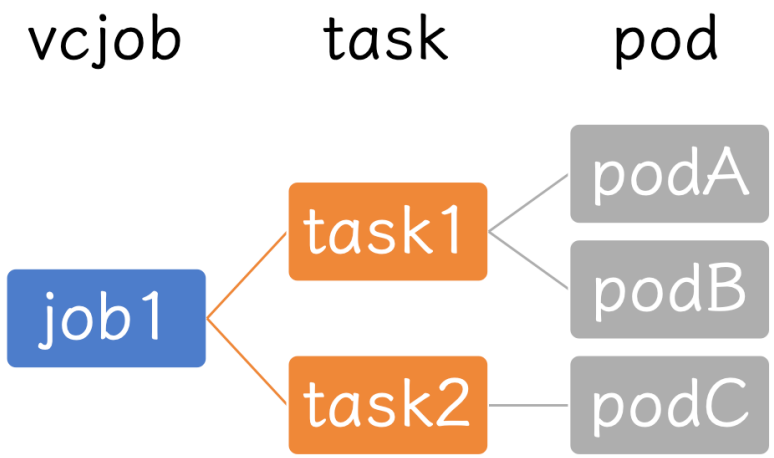


- volcano 项目是华为开源，CNCF 孵化项目。
- 依照 AI 作业特性，建立新的资源抽象。弥补 Kubernetes 原生不足。支持queue，支持一个 job 内多 task，更好的支持批量作业
- 支持多种计算资源，包括但不限于CPU、GPU、NPU。
- 支持多种训练框架，tensorflow，pytorch，飞桨等
- 支持多种调度策略，并且支持多种调度策略组合，比较重要的有gang，priority，binpack，drf等。并且兼容 kubernetes 原生调度策略，例如镜像感知。



易用-vcjob

更好的批处理作业



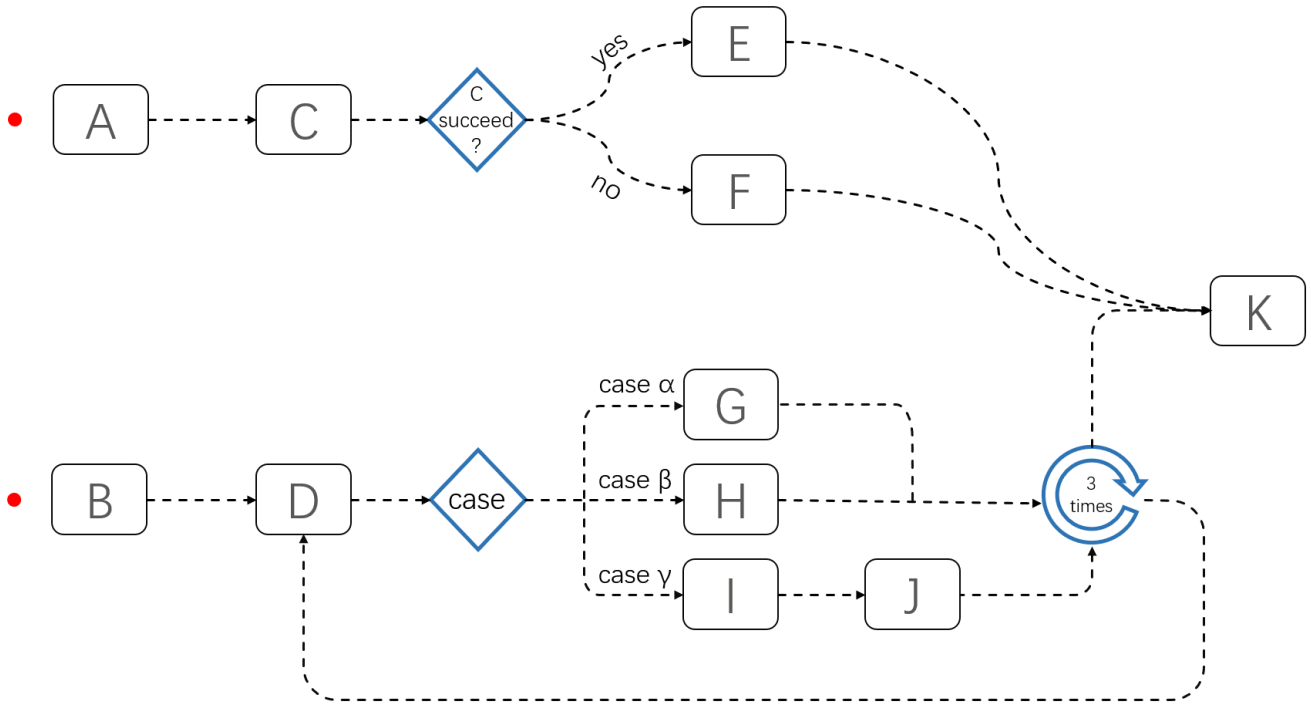
- 一个 vcjob 包含多个 task，每个 task 是不同的角色，一个 task 包含多个 pod
- task1 和 task2 可类比与 tensorflow 的 ps/worker

插件

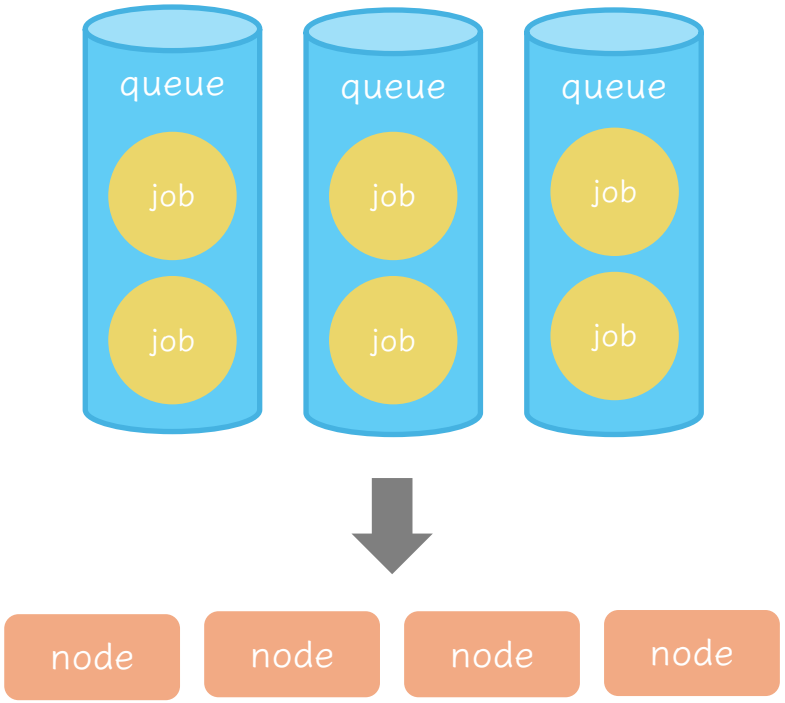
- ssh：pod ssh 免密
- env：创建 pod 索引的环境变量
- svc：为 vcjob 创建 svc 和 networkpolicy
- Pytorch：开启 svc 插件，打开端口，在 pod 中创建 》ytorch 使用的环境变量
- Mpi：强制开启 svc、ssh，打开端口
- Tensorflow：开启 svc 插件，打开端口，在 pod中 创建 Tensorflow 使用的环境变量

易用-jobflow

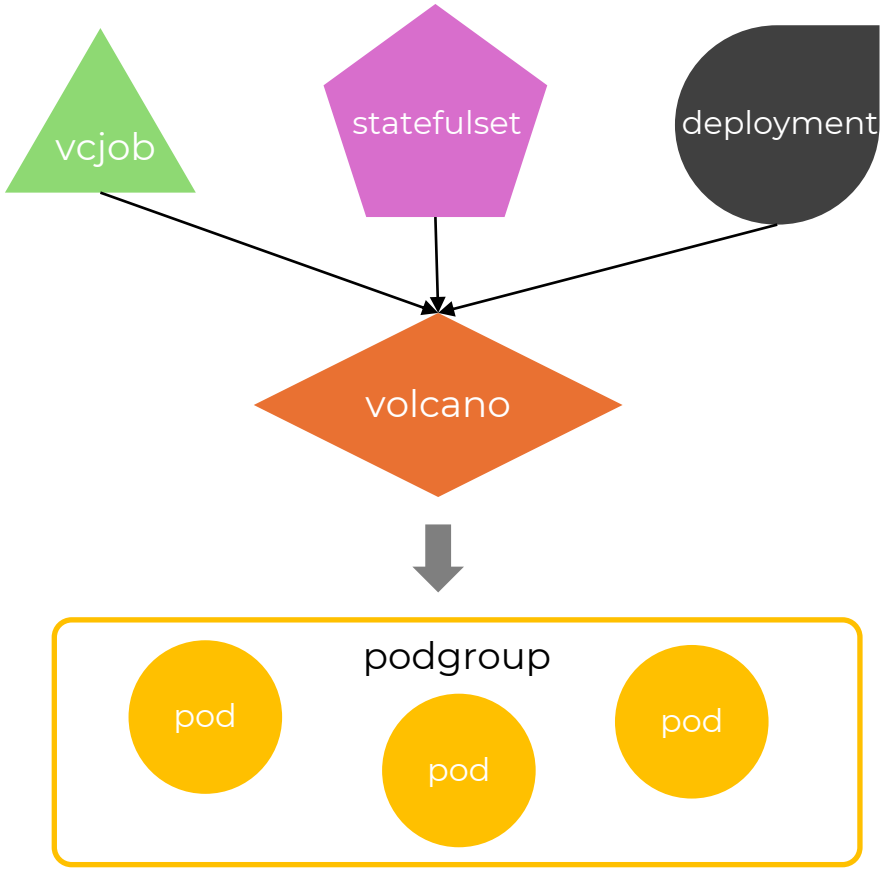
- 支持 vcjob 作业流
- 一种轻量级的 argo workflow 替代
- 支持多种运行条件(ongoing)



易用-queue & podgroup

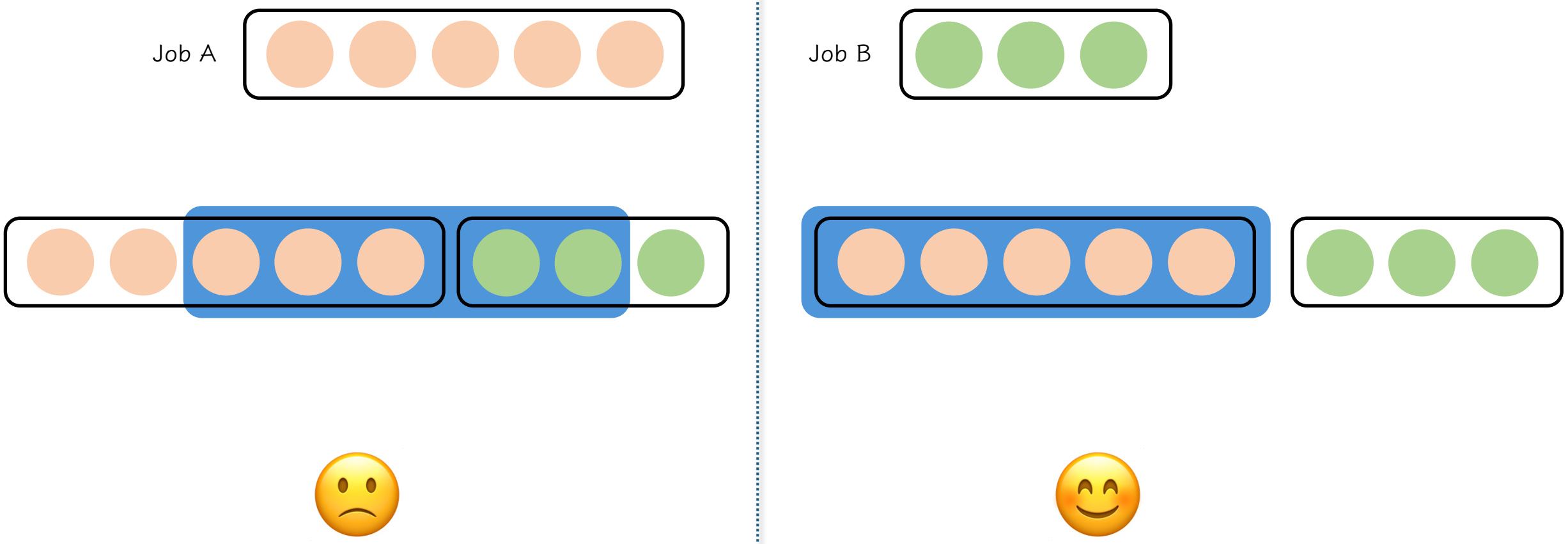


- 多队列支持
- 队列内作业抢占
- 队列间队列抢占
- 队列配额
- 按权重划分资源
- 层级队列(ongoing)



支持将其他 Kubernetes 工作负载转换为 podgroup，使用 volcano 调度

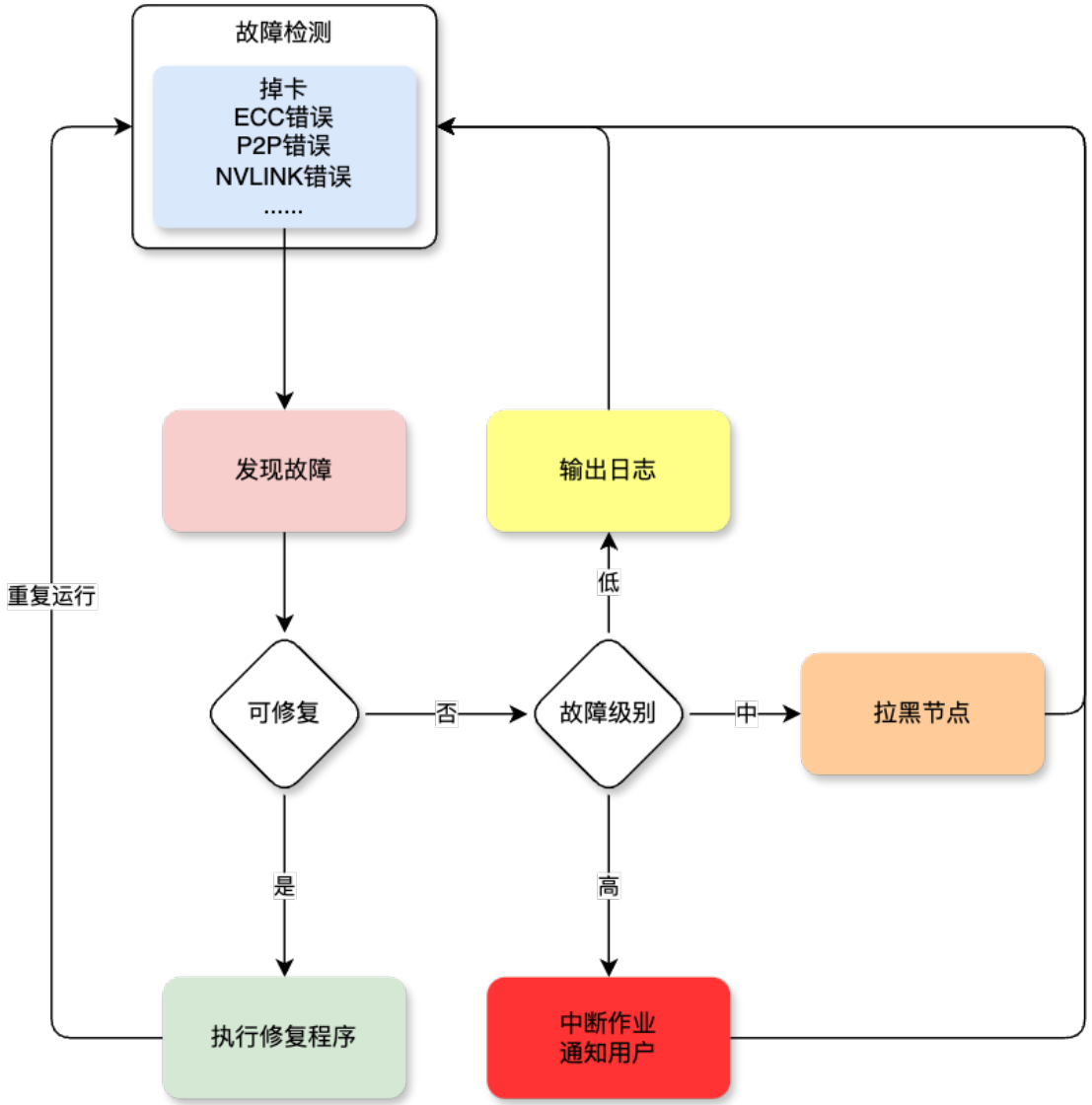
易用-调度策略-gang



故障处理-检测&修复

软硬件故障不可避免

- 自动检测
- 尝试修复

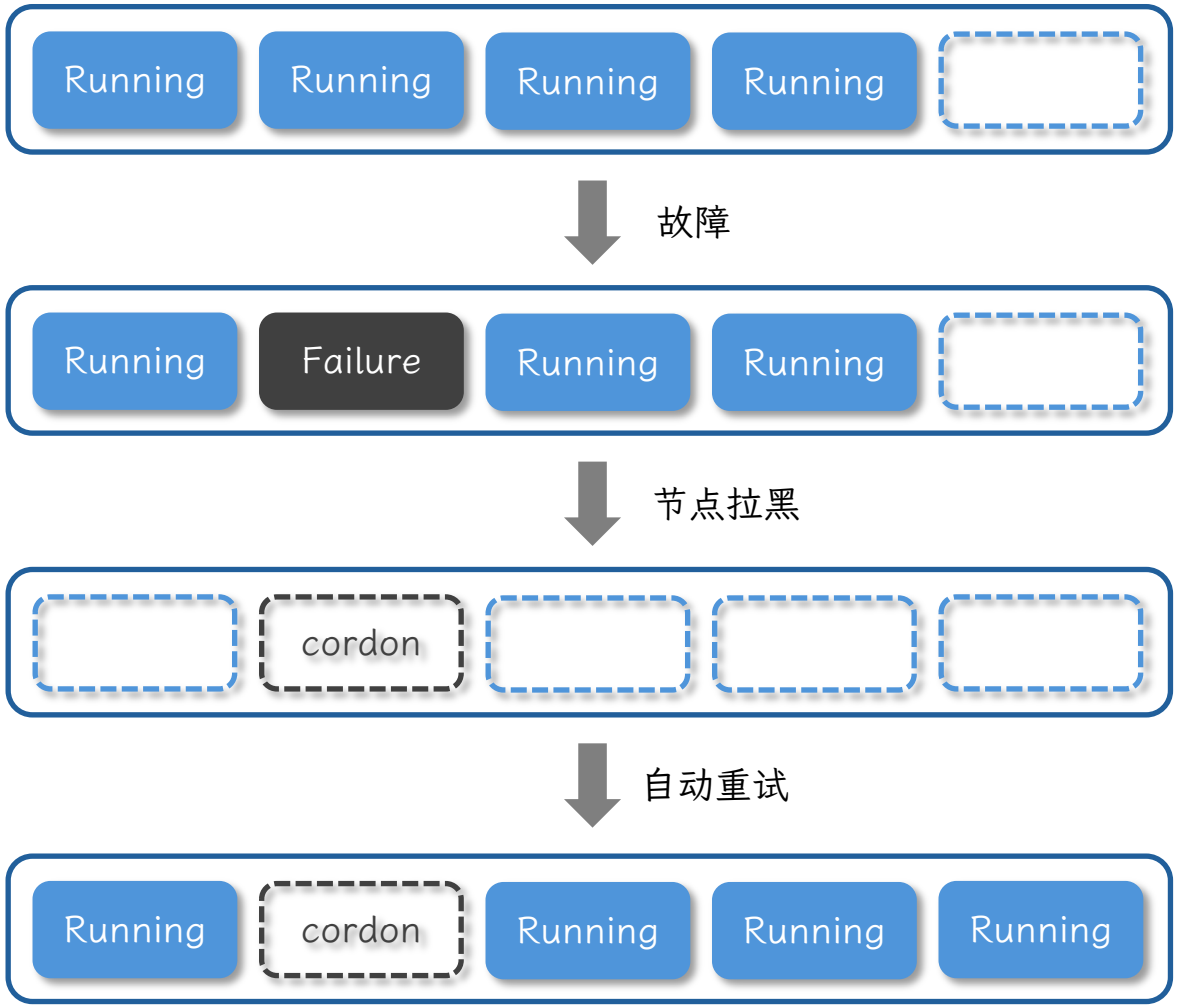


故障处理-作业重试

作业自动重试

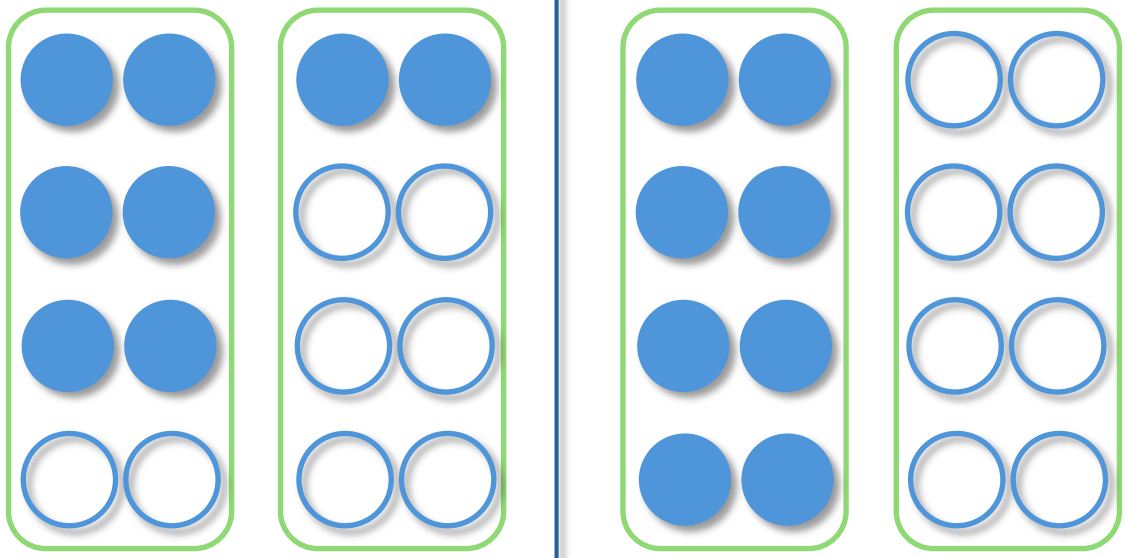
```yaml
apiVersion: batch.volcano.sh/v1alpha1
kind: Job
metadata:
  name: vcjob-demo
spec:
  maxRetry: 3
  minAvailable: 128
  queue: default
  schedulerName: volcano
  tasks:
  - maxRetry: 3
    minAvailable: 1
    name: master
    ...
```

```yaml
policies:
- action: CompleteJob
  event: TaskCompleted
- action: TerminateJob
  event: PodFailed
- action: TerminateJob
  event: PodEvicted
```

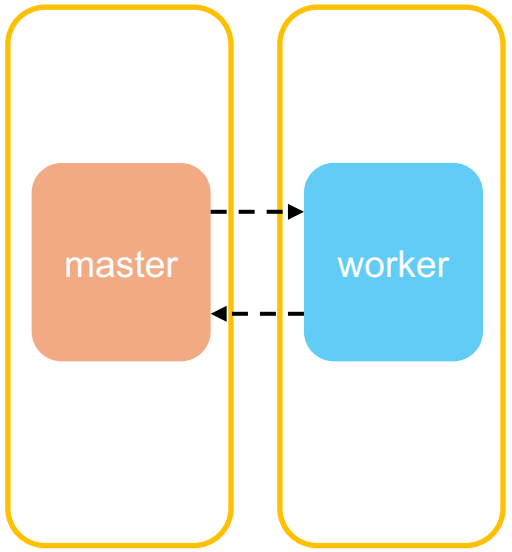


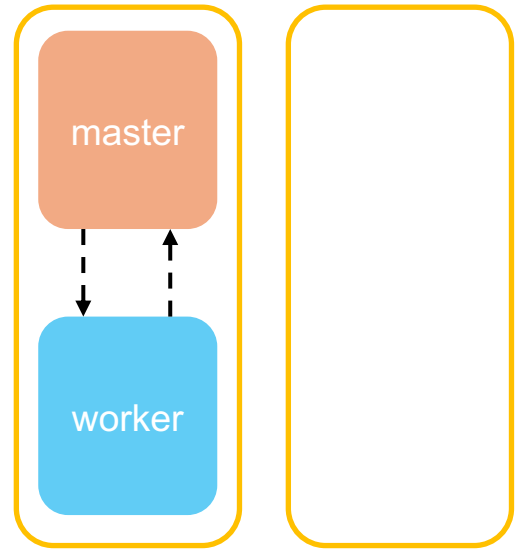
效率提升-binpack&task-topology

binpack



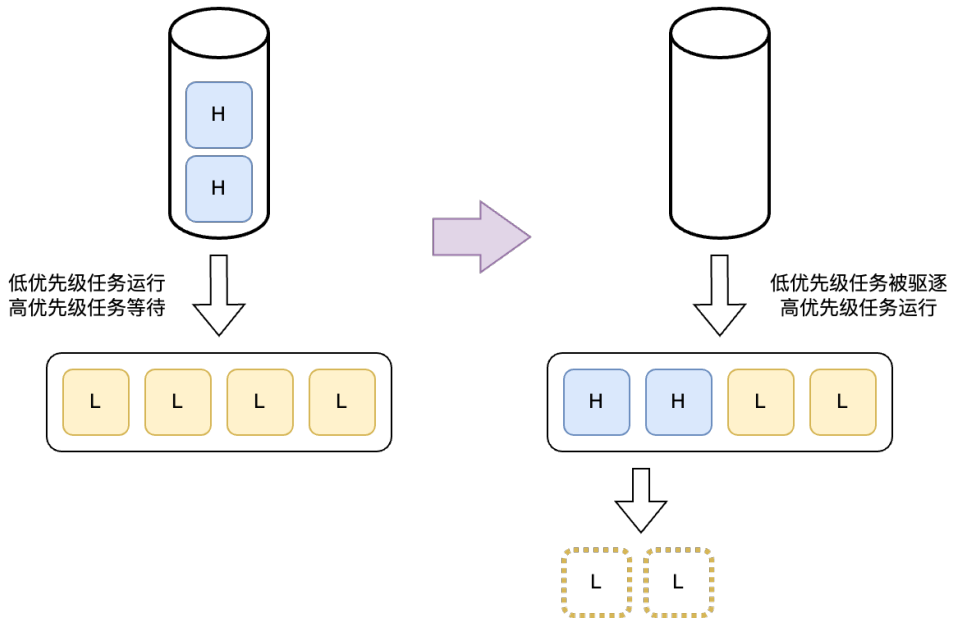
Task-topology



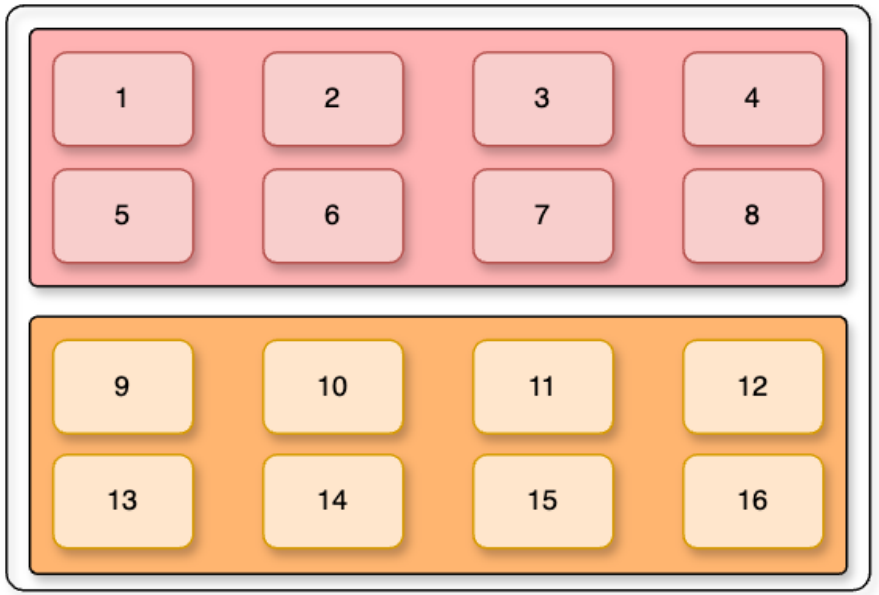


效率提升-抢占&昇腾优化

抢占



昇腾优化

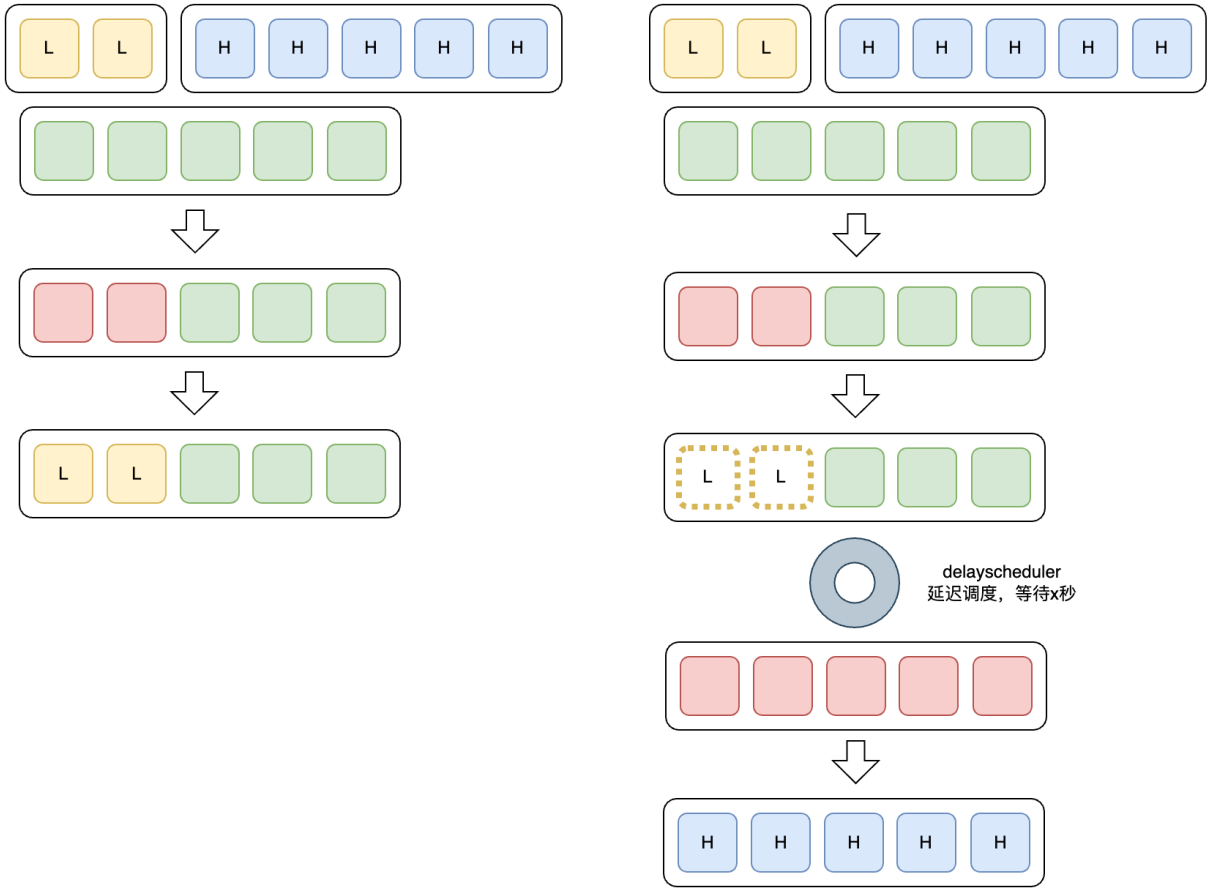


- 单节点 16 张卡
- 每八张为一个环
- 作业需要在同一环内运行

效率提升-启动&清理

延迟调度

- Kubernetes 在释放 Pod 时，每个节点释放时间不同。小任务总是先于大任务运行
- 低优先级任务等待 x 秒后再调度，给节点清理的时间

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