Demand-driven provisioning of Kubernetes-like resource in OSG

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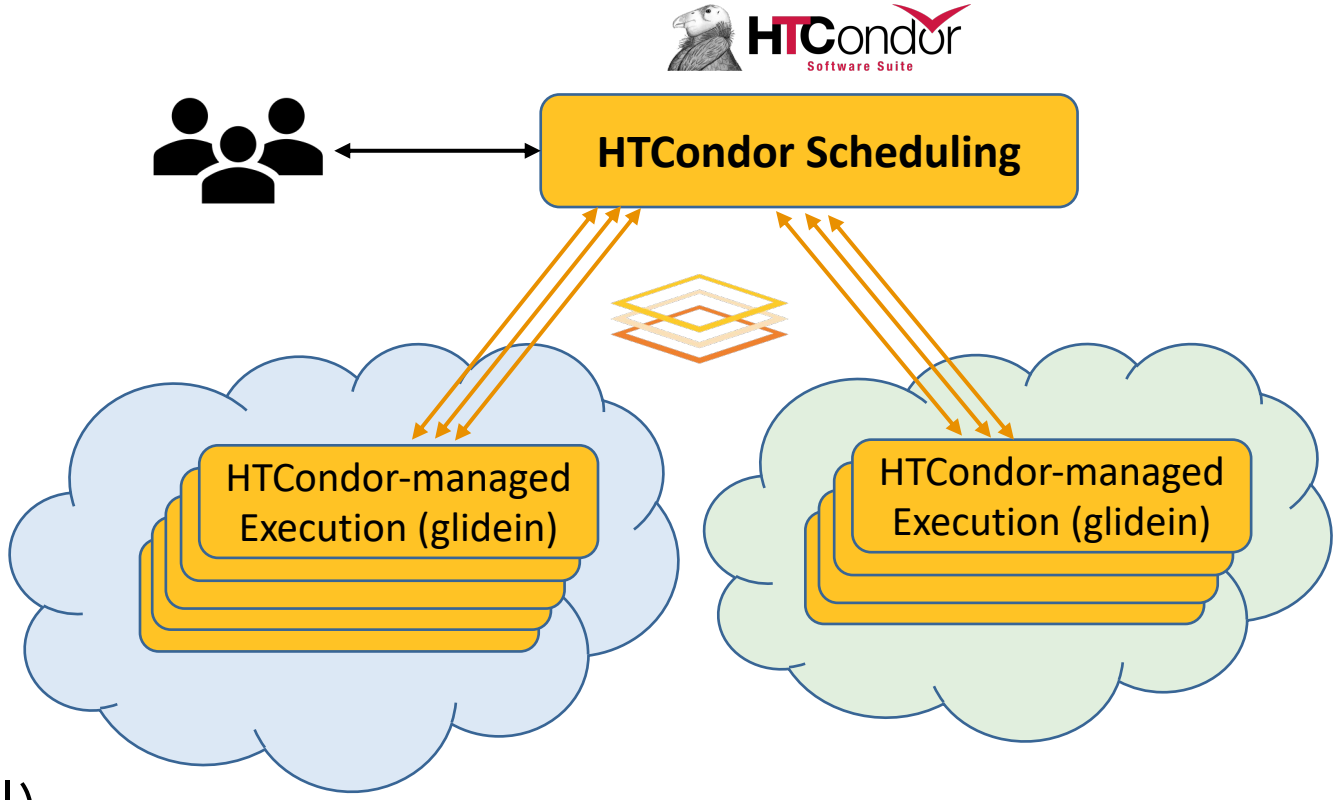
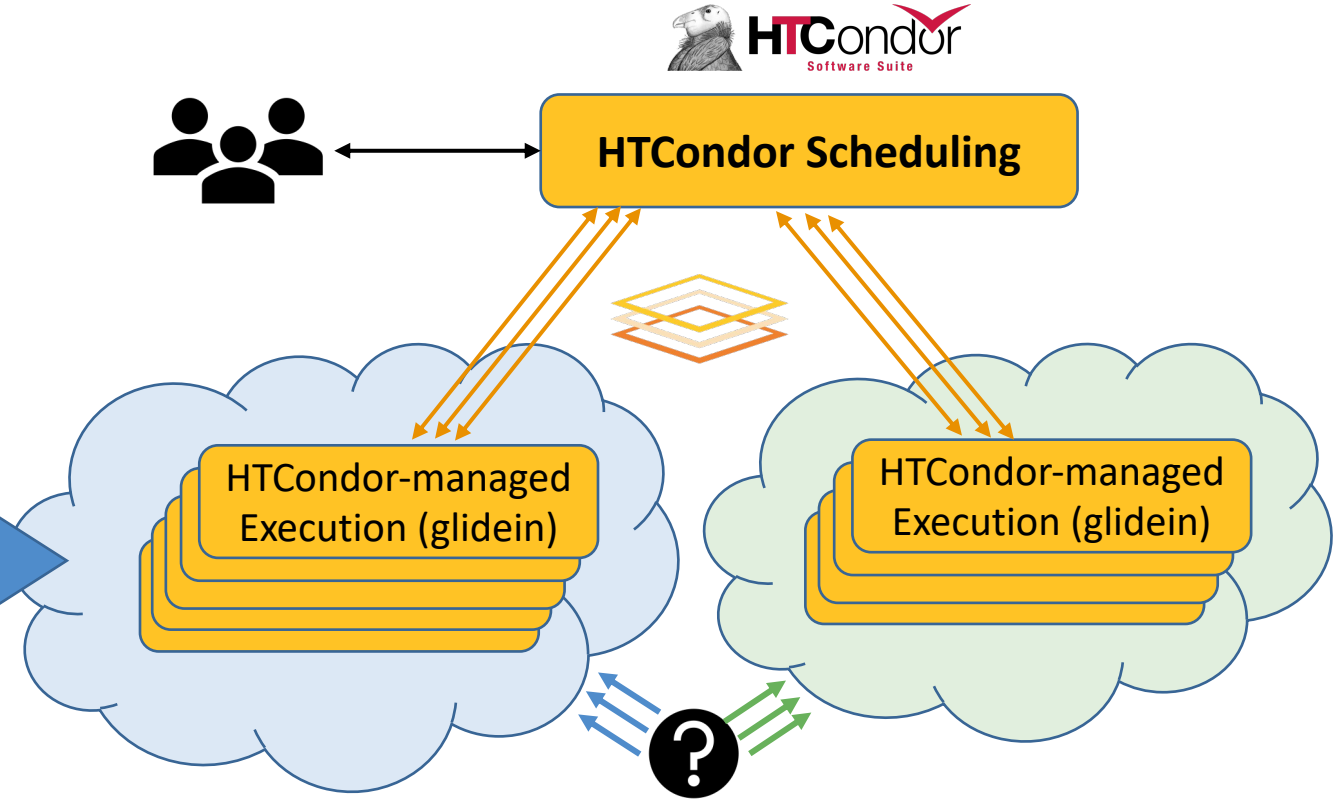
HTCondor and glideins

- HTCondor is a popular science batch systems
  - Core technology in OSG
- HTCondor can be used to managed bare-metal nodes
  - But more often used in conjunction with other provisioning systems
  - i.e., The glidein model (also known as the pilot model)



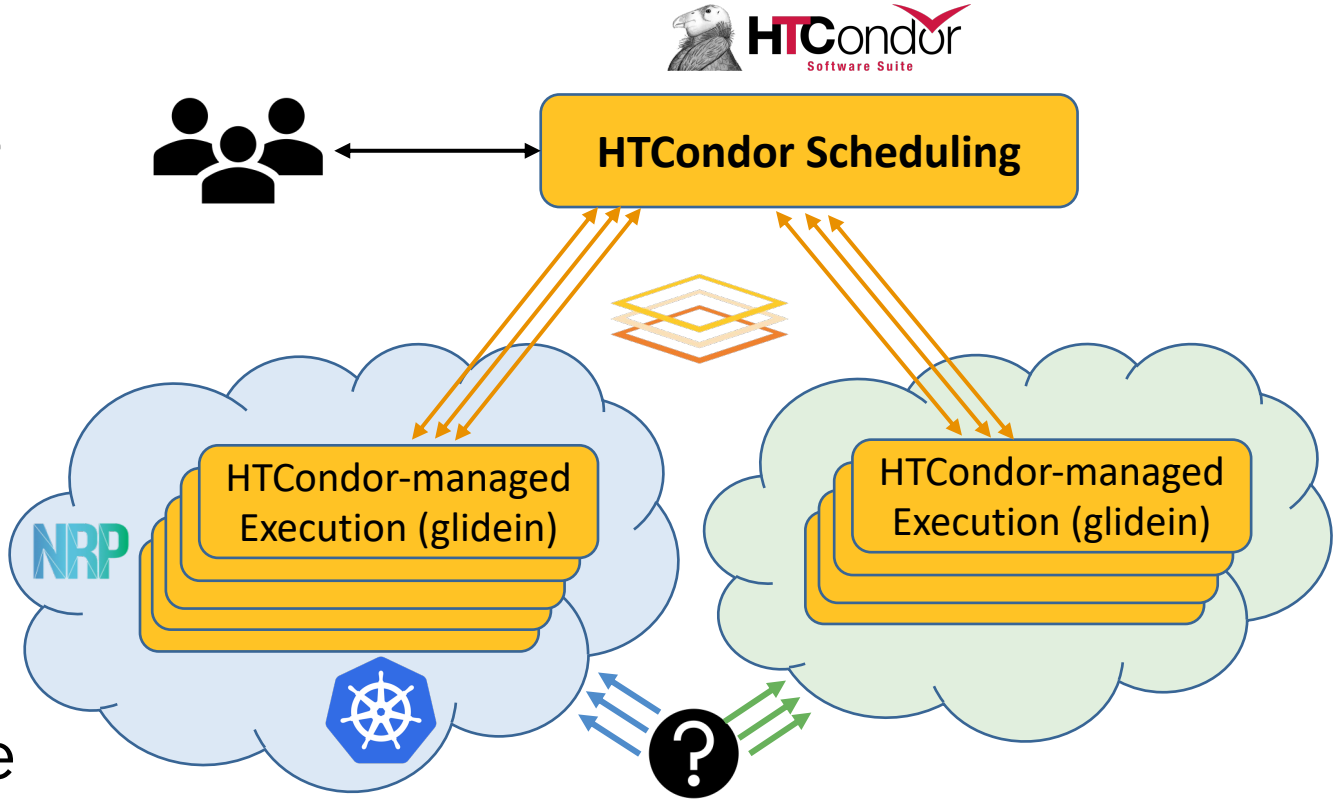
No native glidein provisioning in HTCondor

- HTCondor does not natively provide any resource provisioning capabilities.
- Manual, e.g. backfill, deployment easy, but static
- OSG has been mostly relying on GlideinWMS for dynamic provisioning



No native k8s support in GlideinWMS

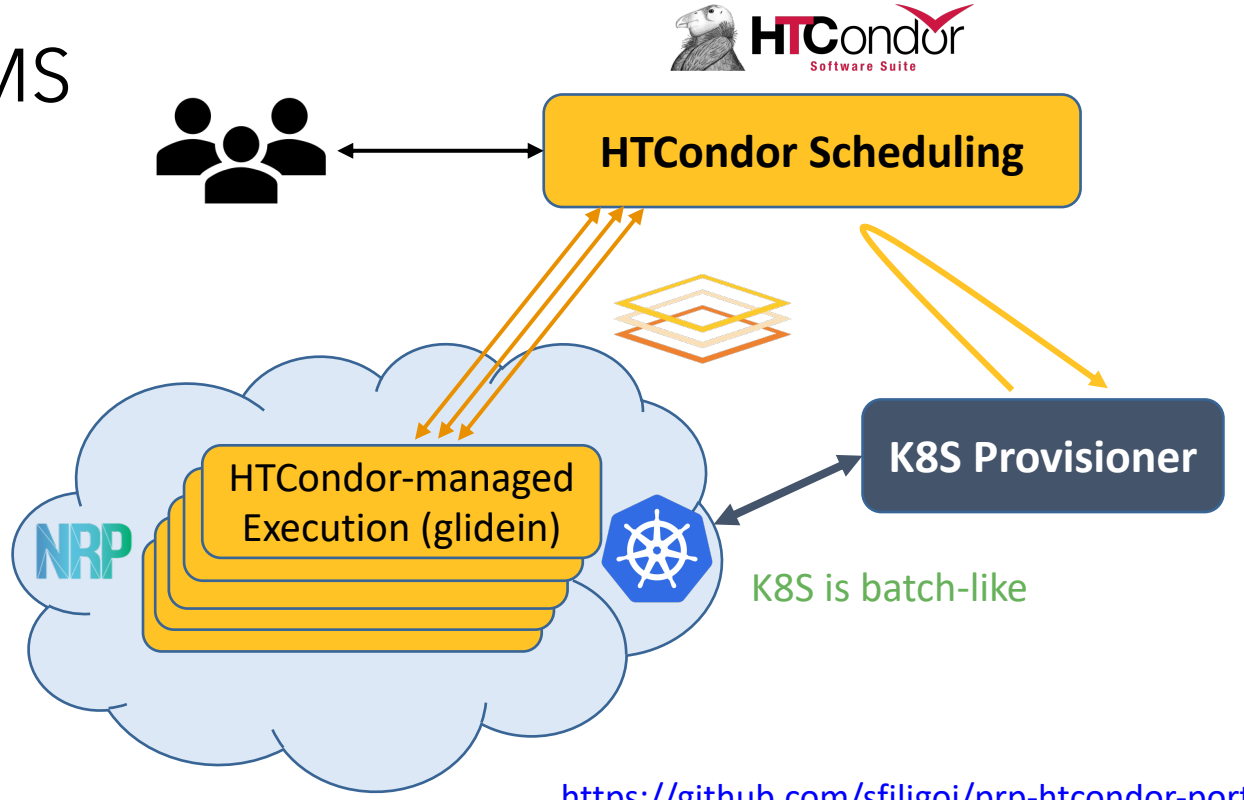
- Kubernetes is becoming a popular bare-metal resource management system
  - While **batch-like**, it is **not a true batch system**
  - GlideinWMS does **not** have native support for k8s
- We used backfill in the past
- But true dynamic provisioning highly desirable



Developed dedicated provisioner

PRP PACIFIC RESEARCH PLATFORM → NRP NATIONAL RESEARCH PLATFORM

- Takes inspiration from GlideinWMS
  - But drastically simplified
  - K8S easier+richer than Grid
- Based on constant pressure
  - Periodically query HTC and K8S
  - If HTC has jobs but there are no pending K8S pods, submit more
- Glideins auto-terminate in case of over-provisioning



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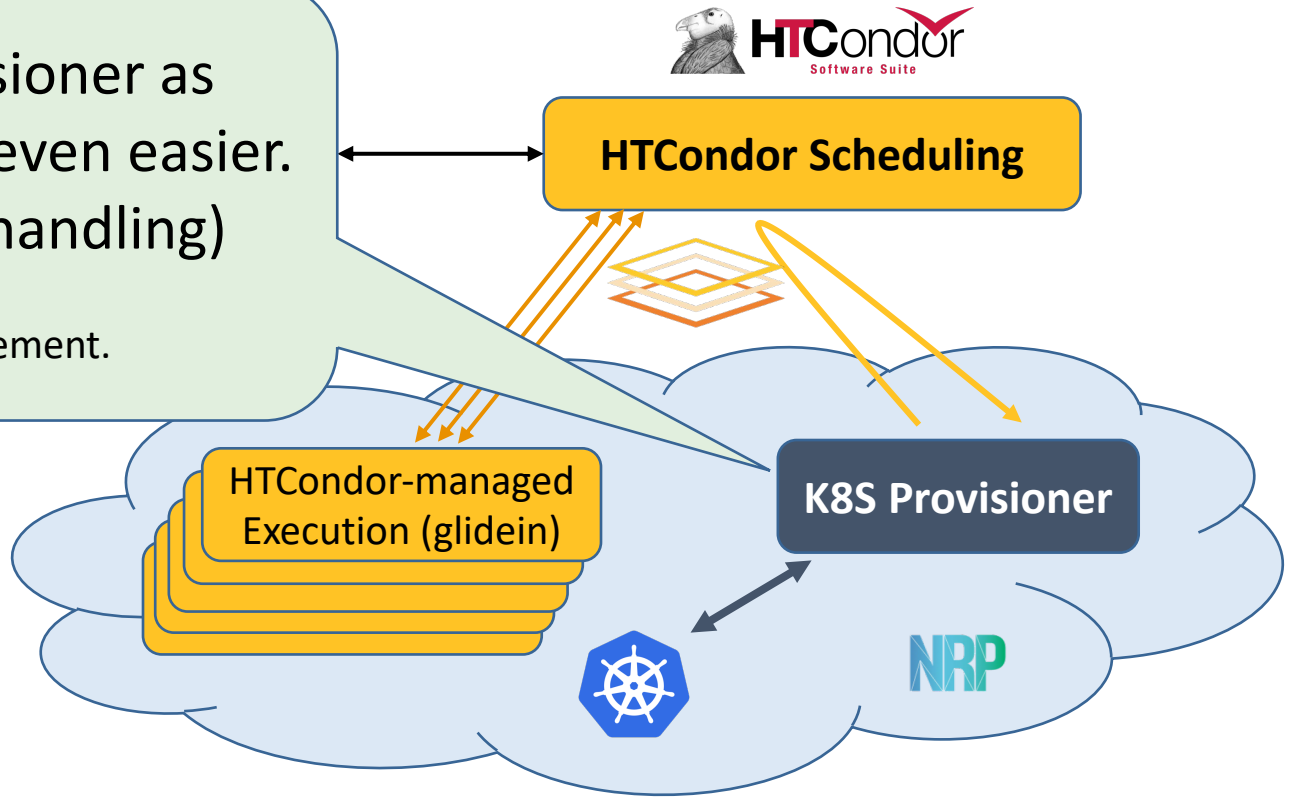
Running the provisioner as a K8S pod makes life even easier. (e.g. secret/token handling)

But not a hard requirement.



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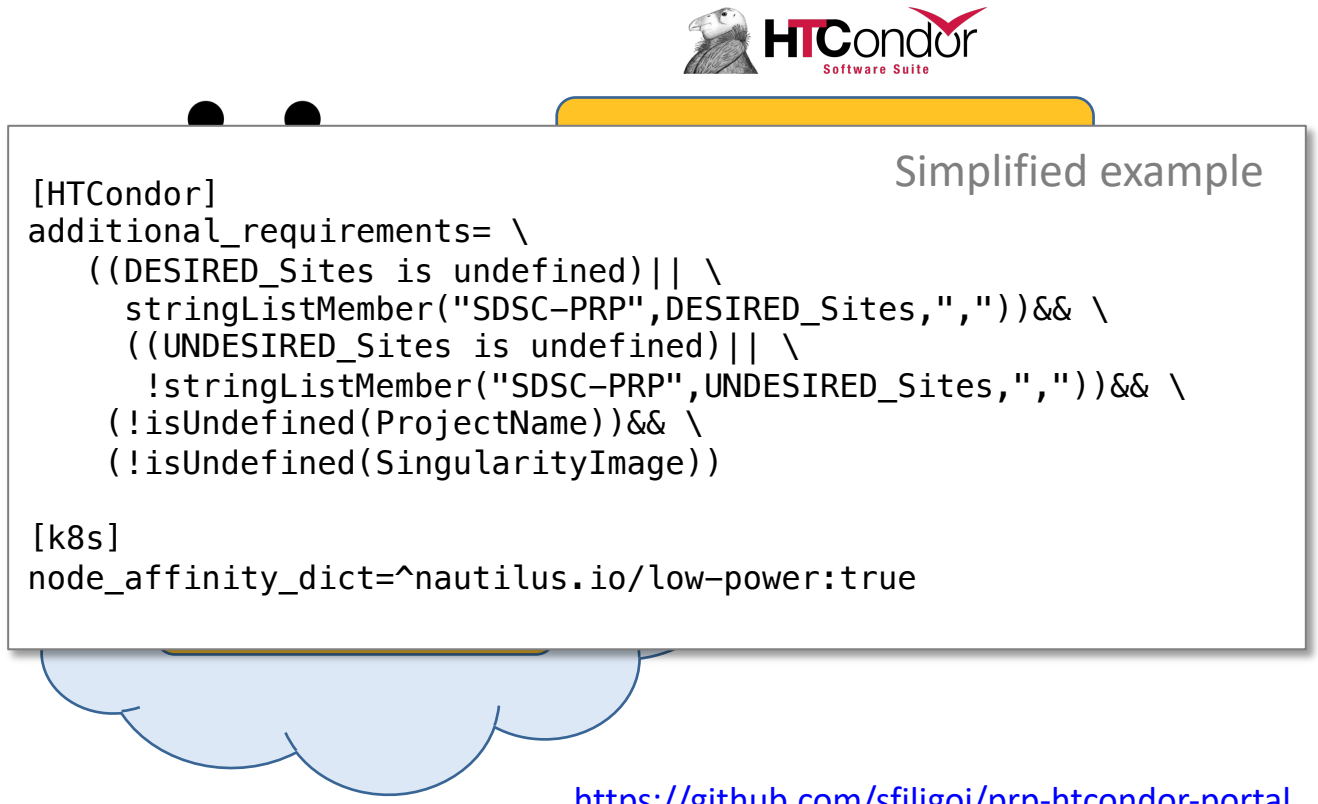
Only eligible HTC jobs

- Not all HTC jobs can/may run in every K8S resource
  - Policy restrictions
  - Technical limits
  - Data locality
- Provisioner fully configurable
  - Within limits of HTCondor ClassAd expressiveness



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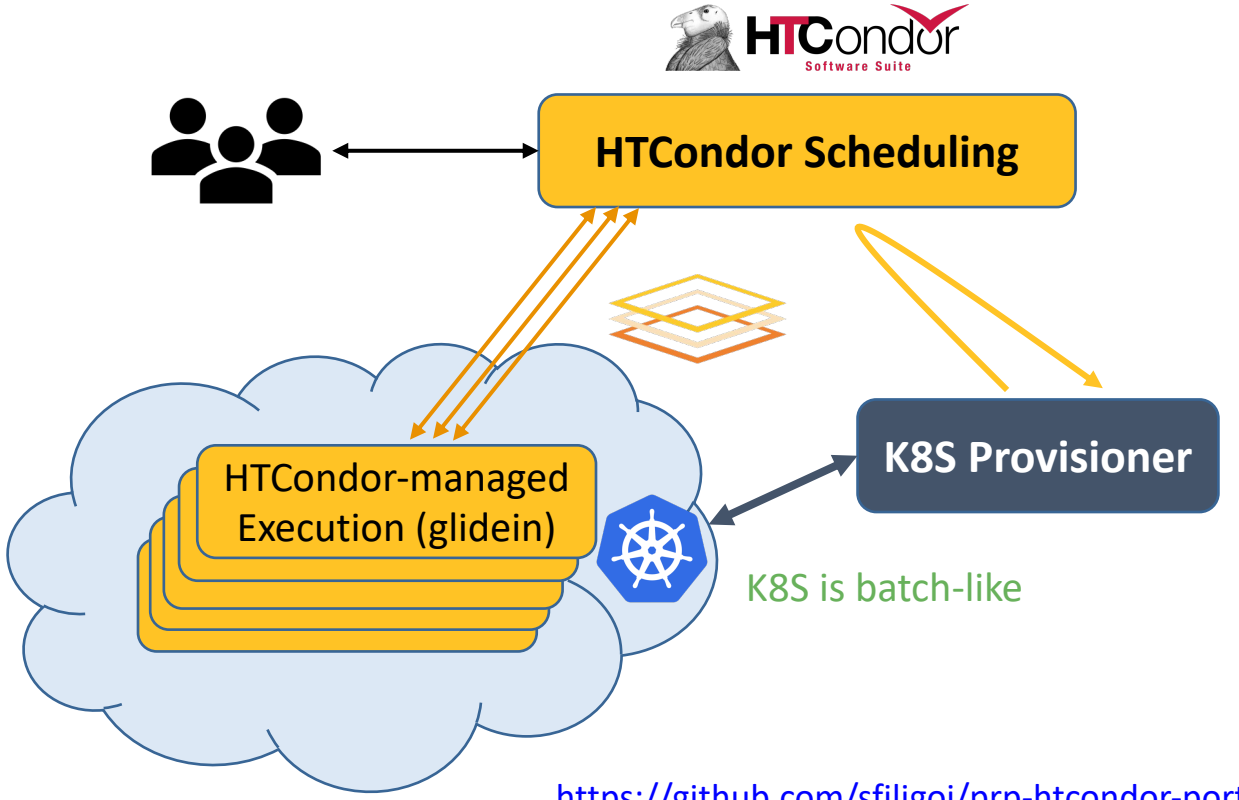
Pushing scheduling to K8S

- Provisioner propagates pending HTC job requirements into glidein pods
  - Currently a tuple of (#CPU, memory, disk, #GPUs)
- Thus, many types of pods
  - K8S fully in control of scheduling
- Each glidein will only serve jobs that match its requirements



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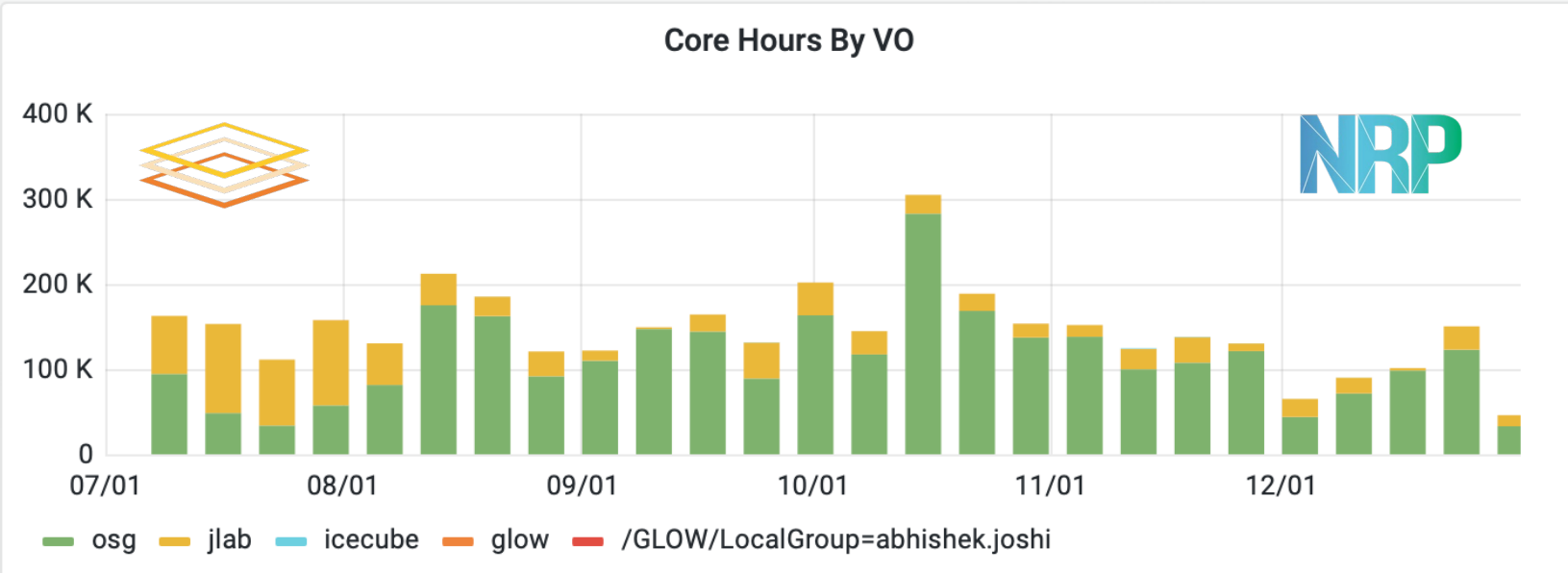
Transparently handles preemption

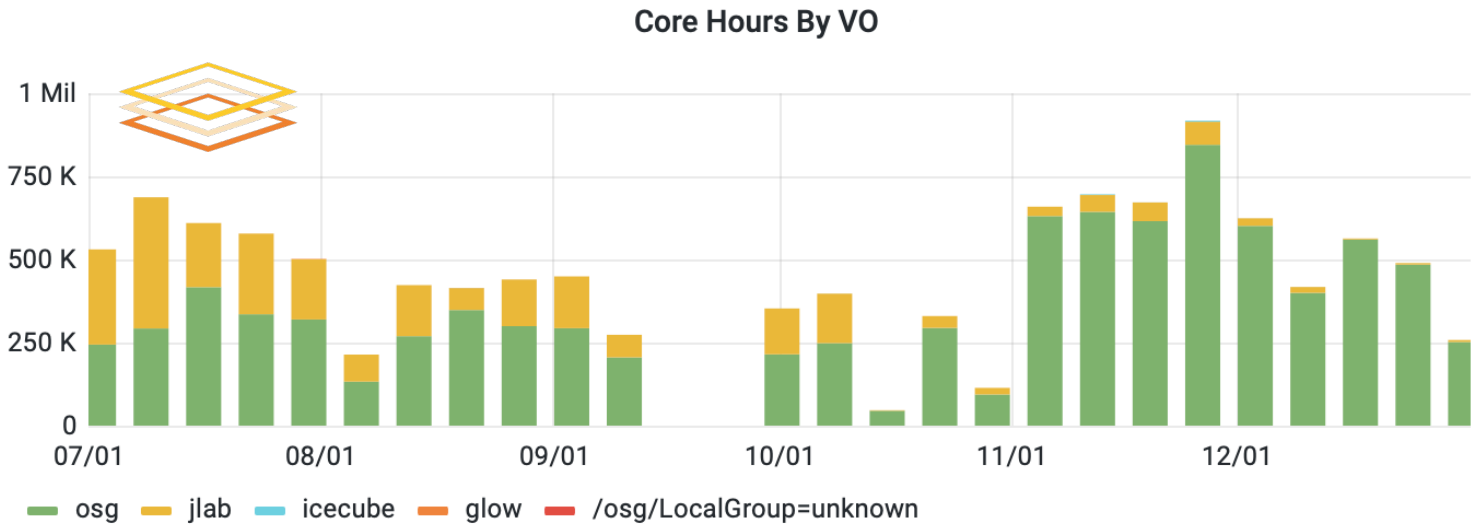
- Preemption often used in K8S as backfill
  - Great way to maximize resource utilization and lower cost
- HTCondor and K8S-based provisioner transparently handle it



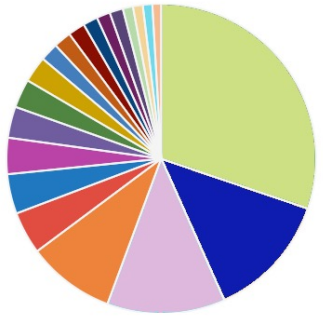
Opportunistic usage of PRP/NRP CPU resources in 2nd half of 2022

Extending to Lancium

- Lancium is a green computing provider
  - Has a IaaS offering
  - Using a proprietary Cloud interface
- Was a major contributor of OSG resources in 2022



Usage of Lancium CPU resources in 2nd half of 2022



Core Hours by Facility

	total
SU ITS	27 Mil
Lancium	12 Mil
San Diego Supercomputer Center	11 Mil
UNL-PATH	8 Mil
FermiGrid	4 Mil

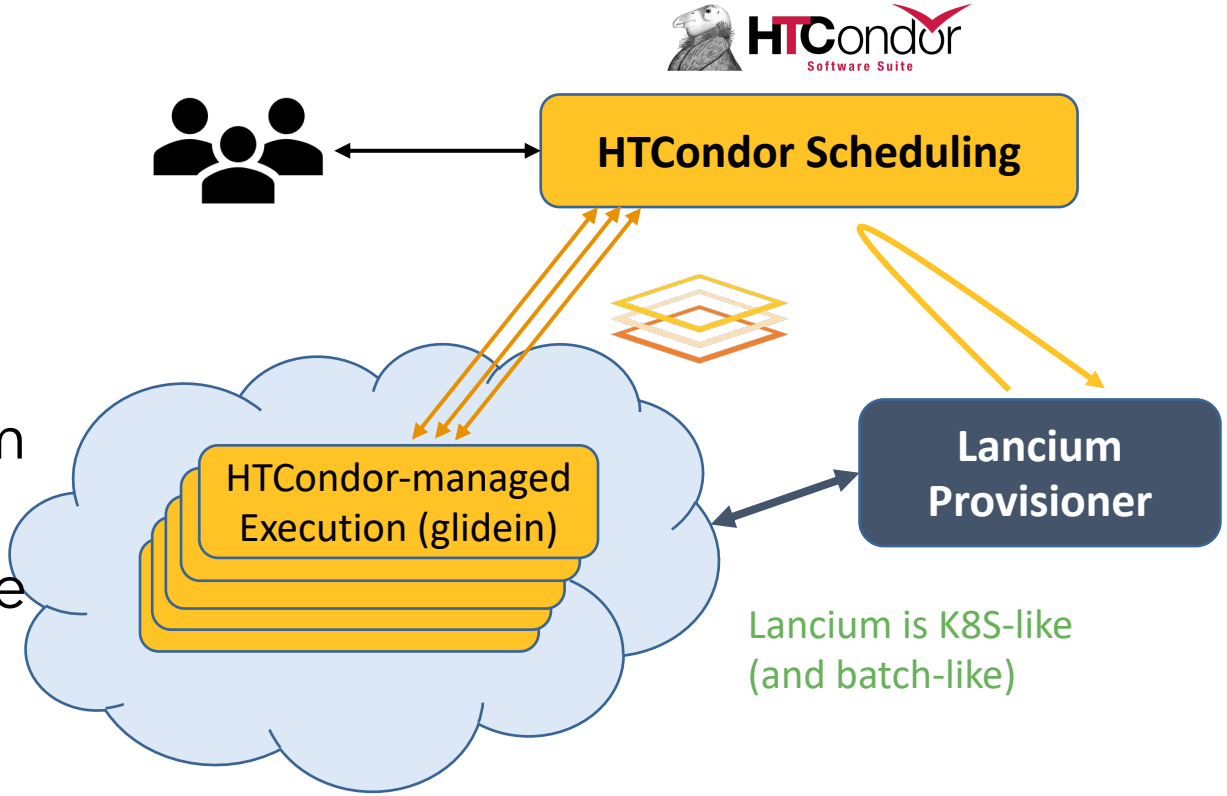
Providers of OSG+JLAB VO CPUs in 2nd half of 2022

Kubernetes-like interface

- Lancium Cloud API proprietary
  - But **Kubernetes-like** in spirit
  - Based on containers, no-client-side-state
- Provisioner uses only Kubernetes basics
  - We like the KISS principle!
  - Lancium API rich enough to express all concepts we were relying on
- Integration required only a little glue
  - Replacing K8S invocations with Lancium invocations

Lancium provisioner

- Most code common with K8S provisioner
  - Mostly an interface change
- Still based on constant pressure
  - Periodically query HTC and Lancium
  - If HTC has jobs but there are no pending Lancium jobs, submit more
- Glideins auto-terminate in case of over-provisioning



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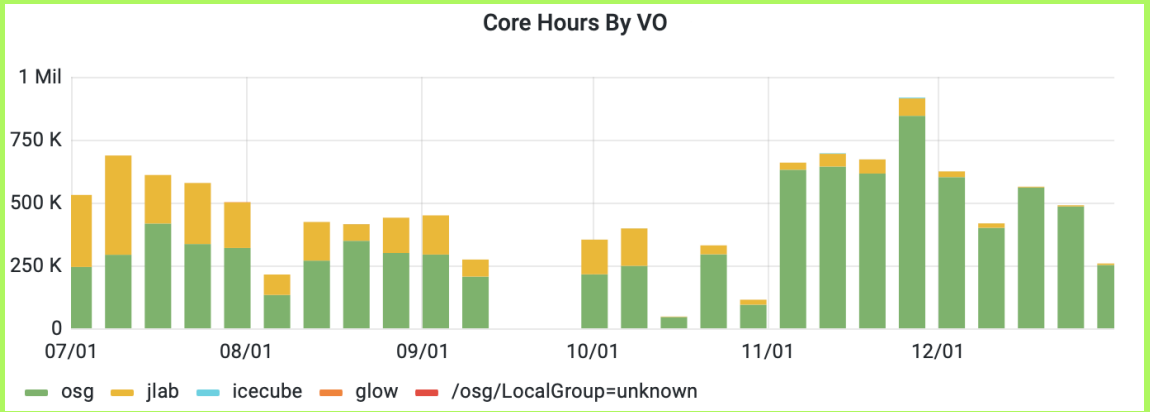
OSG switch to Lancium provisioner in June 2022



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OSG switch to Lancium

In Spring 2023 Lancium decided to abandon its IaaS offering.

So, the Lancium provisioner will be retired soon.
Nevertheless, it proved the feasibility of extending the K8S provisioner to other platforms.

Summary and conclusions

- Kubernetes is becoming increasingly popular and we needed a way to integrate it with HTCondor glidein infrastructure
- We opted for a dedicated, but GlideinWMS-inspired solution
  - Keeping it as simple as possible
  - Available in github, under a BSD license https://github.com/sfiligoi/prp-htcondor-portal
- Currently in use to make good use of opportunistic K8S resources on the PNRP on behalf of OSG, but also IceCube
  - We extended it to support Lancium, too

Acknowledgements

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