UC San Diego


At HTCondor Week 2019

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for the PRP team

# An opportunistic HTCondor pool inside an interactive-friendly Kubernetes cluster

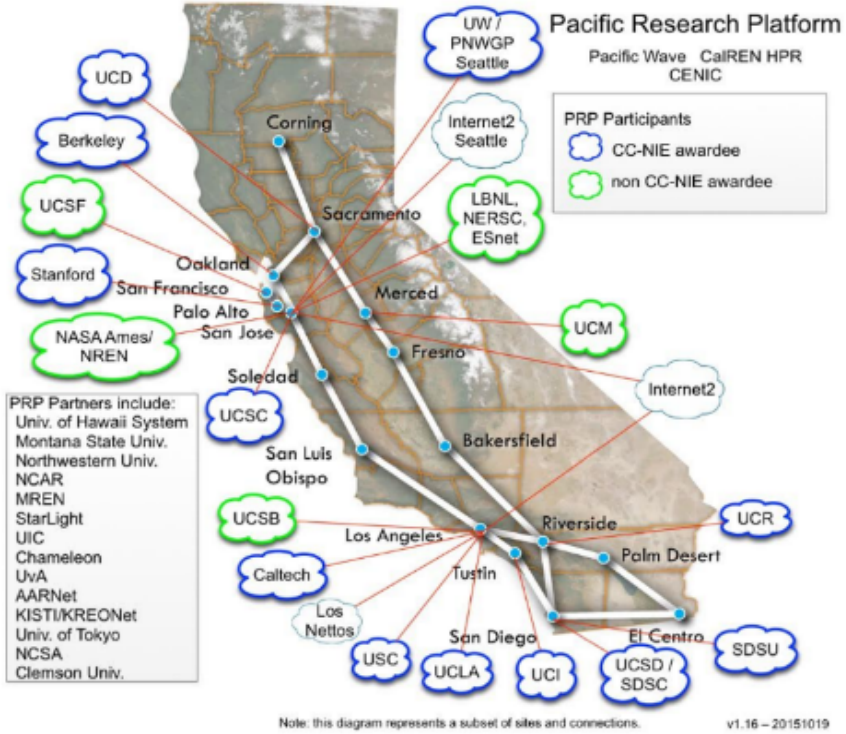
# Outline

- Where do I come from?
- What we did?
- How is it working?
- Looking head

# The Pacific Research Platform

- The PRP originally created as a regional networking project
  - Establishing end-to-end links between 10Gbps and 100Gbps

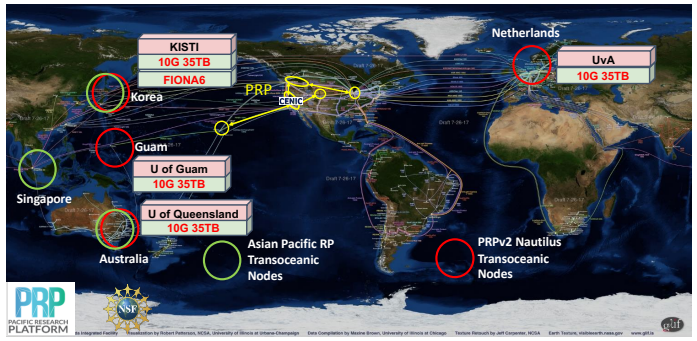
PACIFIC RESEARCH PLATFORM




(GDC)

# The Pacific Research Platform

- The PRP originally created as a regional networking project
  - Establishing end-to-end links between 10Gbps and 100Gbps
- Expanded nationally since
  - And beyond, too

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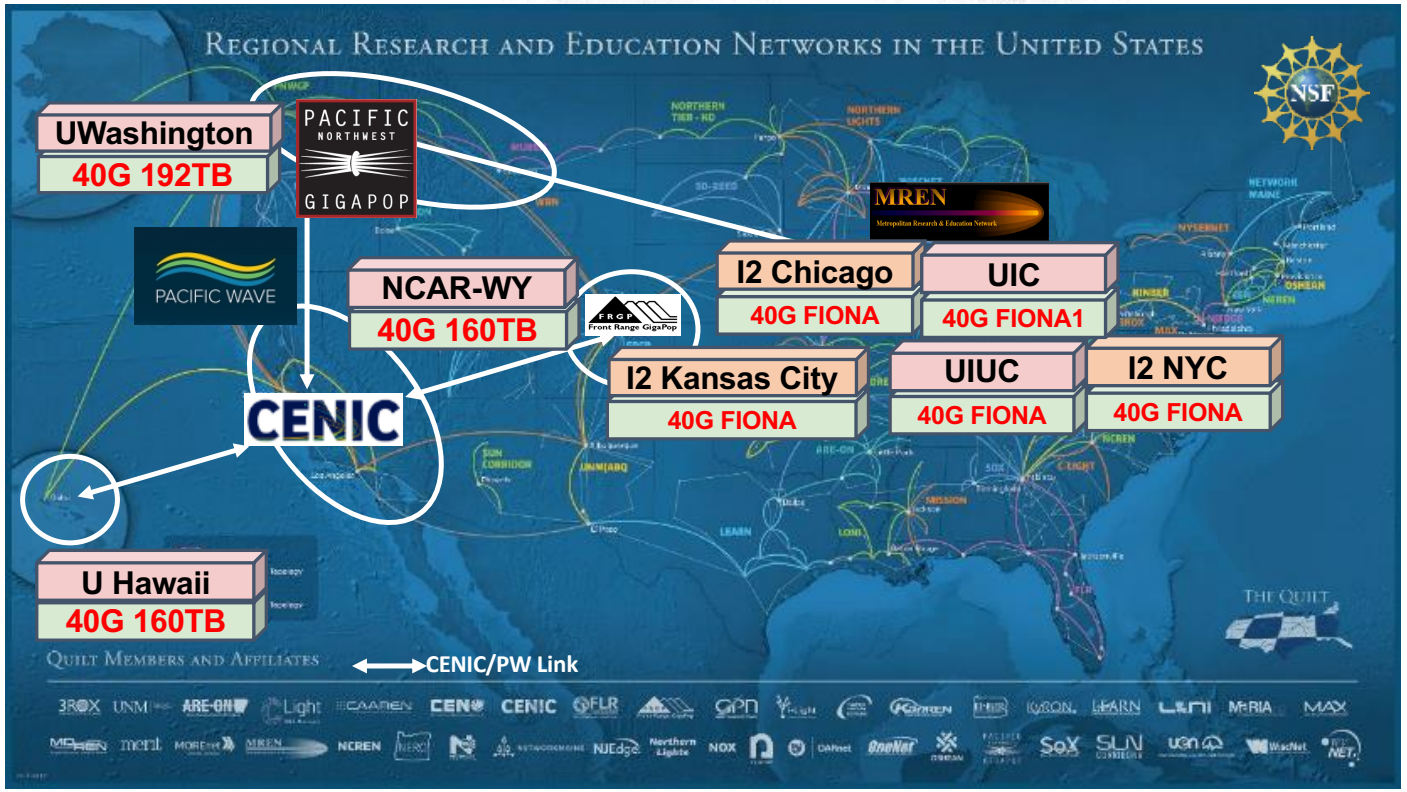

# The Pacific Research Platform

- Recently the PRP evolved in a major resource provider, too
  - Because scientists really need more than bandwidth tests
  - They need to share their data at high speed and compute on it, too
- The PRP now also provides
  - Extensive compute power – About 330 GPUs and 3.5k CPU cores
  - A large distributed storage area - About 2 PBytes
- Select user communities now directly use all the resources PRP has to offer
  - Still doing all the network R&D in the same setup, too
  - We call it the Nautilus cluster


# Kubernetes as a resource manager

| | |
|---|---|
| Industry standard | • Large and active development and support community |
| Container based | • More freedom for users |
| Flexible scheduling | • Allows for easy mixing of service and user workloads |

# Designed for interactive use

Users expect to get what they need when they need it

- Makes for very happy users

Congestion happens only very rarely

- And is typically short in duration

# Opportunistic use

# Kubernetes priorities


| | |
|---|---|
| Priorities natively supported in Kubernetes | • Low priority pods only start if no demand from higher priority ones |
| Preemption out of the box | • Low priority pods killed the moment a high priority pod needs the resources |
| Perfect for opportunistic use | • Just keep enough low-priority pods in the system |

https://kubernetes.io/docs/concepts/configuration/pod-priority-preemption/

# HTCondor as the OSG helper

PRP wanted to give opportunistic resources to Open Science Grid (OSG) users

- Since they can tolerate preemption


But OSG does not have native support for Kubernetes

- Supports only resources provided by batch systems


We thus instantiated an HTCondor pool

- As a fully Kubernetes/Containerized deployment

# HTCondor in a (set of) container(s)

| | |
|---|---|
| Putting HTCondor in a set of containers is not hard | • Just create an image with HTCondor binaries in it!<br>• Configuration injected through Kubernetes pod config |
| HTCondor deals nicely with ephemeral IPs | • The Collector must be discoverable – Kubernetes service<br>• Everything else just works from there |
| Persistency needed for the Schedd(s) | • And potentially for the Negotiator, if long term accounting desired<br>• Everything else can live off ephemeral storage |

# Service vs Opportunistic

## Collector and Schedd(s) deployed as high priority service pods

- Should be running at all times
- Few pods, not high CPU or GPU users, so OK
- Using Kubernetes Deployment to re-start the pods in case of HW problems and/or maintenance
- Kubernetes Service used to get a persistent routing IP to the collector pod

## Startds deployed as low priority pods

**Pure opportunistic**

- Hundreds of pods in the Kubernetes queue at all times, many in Pending state
- HTCondor Startd configured to accept jobs as soon as it starts and forever after
- If pod preempted, HTCondor gets a SIGTERM and has a few seconds to go away

# Then came the users

Everything was working nicely, until we let in real users

- Well, until we had more than a single user

OSG users got used to rely on Containers

- So they can use any weird software they like

But HTCondor Startd already running inside a container!

- Cannot launch a user-provided container

Not without elevated privileges

# Then came the users

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| OSG users got used to rely on Containers | • So they can use any weird software they like |
| But HTCondor Startd already running inside a container! | • Cannot launch a user-provided container |
| So I need to provide user-specific execute pods | • How many of each kind? |

# Dealing with many opportunistic pod types

| | |
|---|---|
| Having idle Startd pods not OK anymore | • A different kind of pod could use that resource<br>• A glidein-like setup would solve that |
| Keeping pods without users not OK anymore | • They will just terminate without ever running a job<br>• Who should regulate the “glidein pressure”? |
| How do I manage fair share between different pod types? | • Kubernetes scheduling is basically just priority-FIFO |
| How am I to know what Container images users want? | • Ideally, HTCondor should have native Kubernetes support |

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I know how to implement this.

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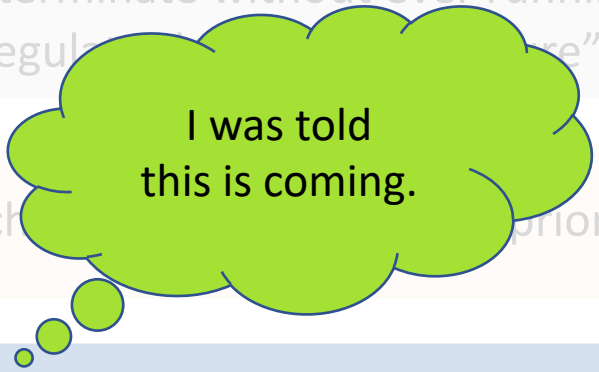

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In OSG-land, glideinWMS solves this for me.

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**No concrete plans on how to address these yet.**

# Dealing with many opportunistic pod types

For now, I just periodically adjust the balance

- A completely manual process

Currently supporting only a few, well behaved users

- Maybe not optimal, but good enough

But looking forward to a more automated future

# Are side-containers an option?

## Ideally, I do want to use user-provided, per-job Containers

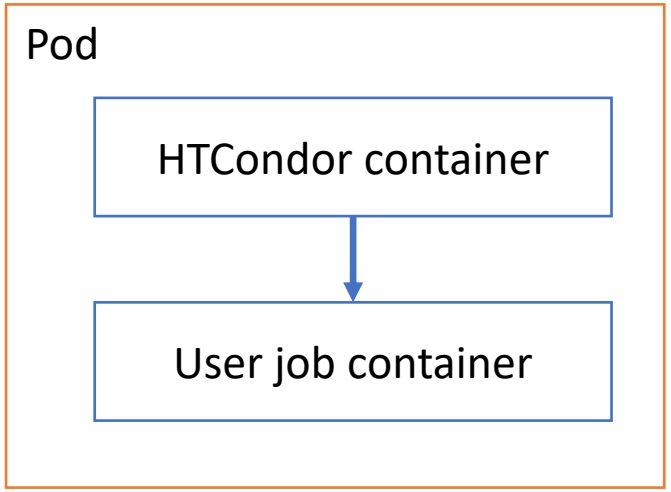
- Running HTCondor and user jobs in separate pods not an option due to opportunistic nature

## But Kubernetes pods are made of several Containers

- Could I run HTCondor in a dedicated Container?
- Then start the user pod in a side-container?

## Pretty sure currently not supported

- But, at least in principle, fits the architecture
- Would also need HTCondor native support



# Will nested Containers be a reality soon?

It has been pointed out to me that latest CentOS supports unprivileged Singularity

Have not tied it out

- Probably I should

Cannot currently assume all of my nodes have a recent-enough kernel

- But eventually will get there

# Looking ahead

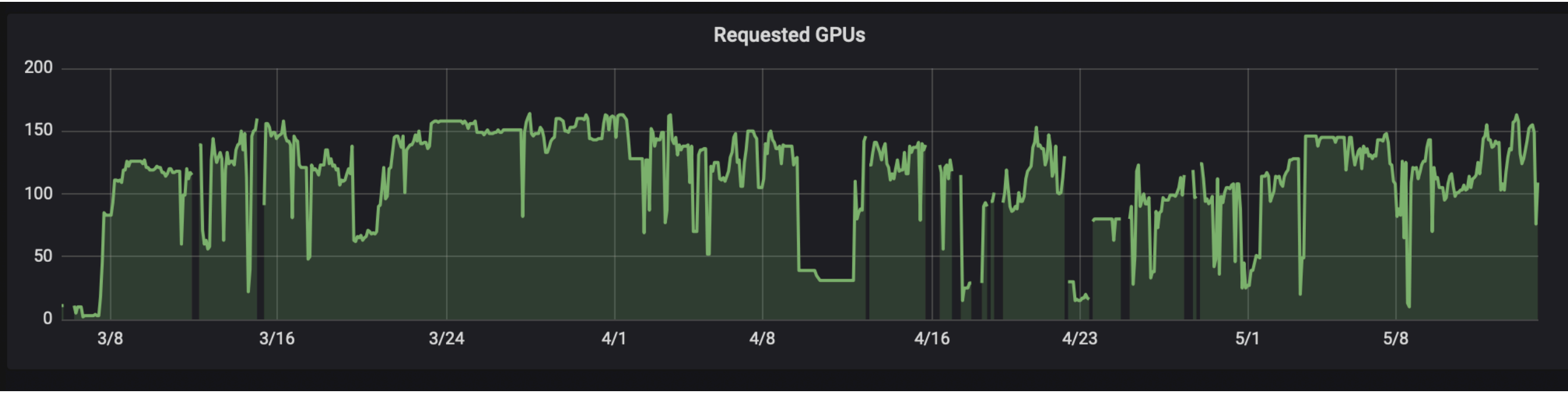
Looking forward to a more automated future

Will do what I have to myself

Would be happier if I could use off-the-shelf solutions

# A final picture

- Opportunistic GPU usage over the past few months



# Summary

- We created an opportunistic HTCondor pool in the PRP Kubernetes cluster
  - OSG users can now use any otherwise-unused cycles
- The lack of nested containerization forces us to have multiple execute pod types
- Some micromanagement currently needed, hoping for more automation in the future

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