DEVCONF.cz

Shifting Performance Engineering Left

Building Performance into the Development Cycle

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kube-burner

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- 8 years in Red Hat
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What we'll discuss today

1. The problem
2. Shift-left engineering
3. Continuous Performance Testing (CPT)
4. Workflow
5. Tooling
   1. Kube-burner
      1. Demo
6. Case studies
7. Challenges and next steps

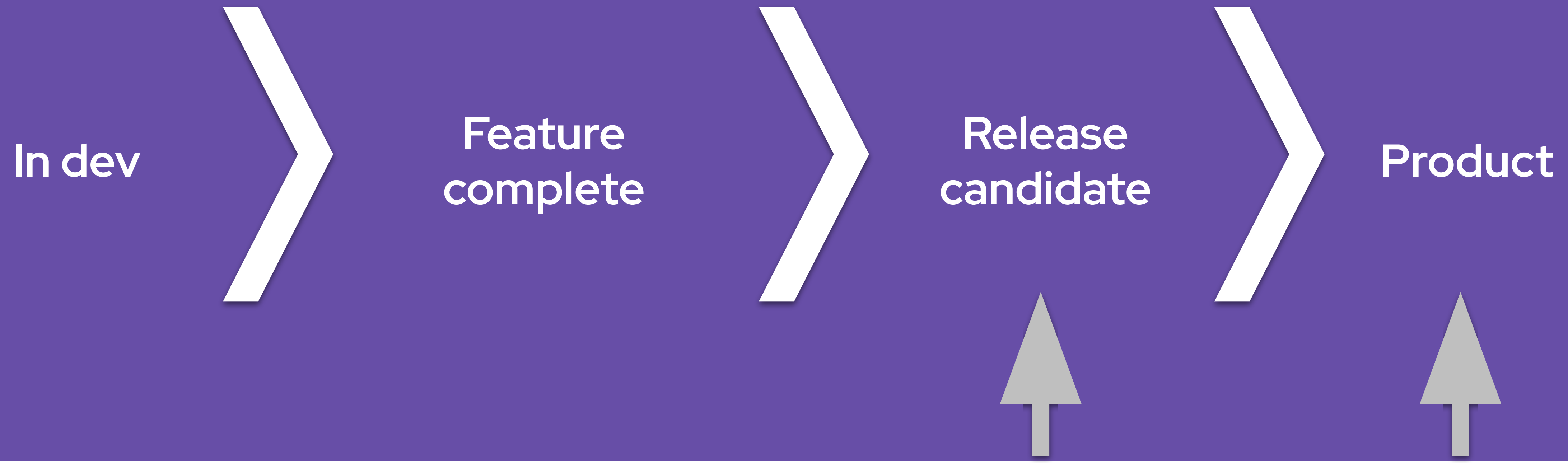
Continuous Performance Testing

The problem

- Performance testing often occurs **too late in the pipeline**
- Late detection of performance issues increases **cost**
- Real-world consequences: downtime, latency, etc.

Performance testing - the past

OpenShift product lifecycle



In dev

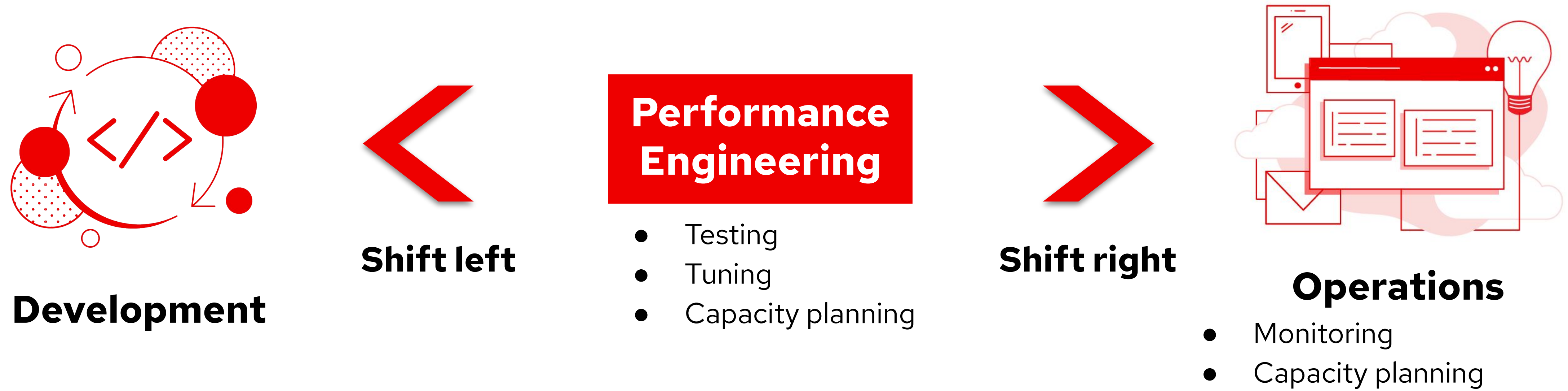
Feature complete

Release candidate

Product

At best we normally would fit in at the end of the development cycle

Shift-left engineering



Development

Shift left

Performance Engineering

- Testing
- Tuning
- Capacity planning

Shift right

Operations

- Monitoring
- Capacity planning

Alexander Podelko, *Continuous Performance Testing: Challenges and approaches*

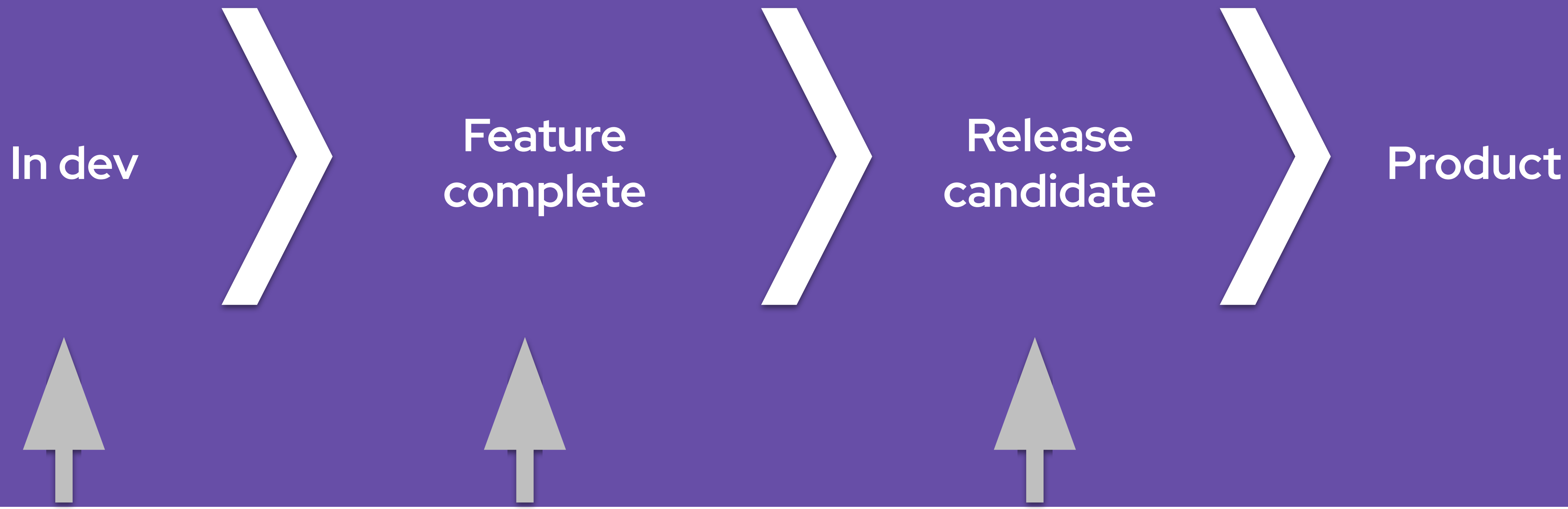
What is CPT?

Continuous Performance Testing (CPT) is the practice of executing performance benchmarks (tests) continuously throughout the development lifecycle.

The execution of said Performance benchmarks is **orchestrated in an automated pipeline** (like Jenkins, Prow, etc.), preferably in the pipeline your developers are working out of.

CPT goals

OpenShift product lifecycle



In dev

Feature complete

Release candidate

Product

Where we should fit in the development cycle

Why CPT?

- Shifts Performance testing left
- Earlier feedback enables faster fixes
- Reduces overall testing costs
- Improves developer ownership of performance

  → Continuous Improvement Mindset

- More time for technical improvements
- Allows us to drastically improve the coverage matrix and frequency of the testing
  - More data → Need for automatic **performance regression frameworks**
    - **Change point detection** mechanisms

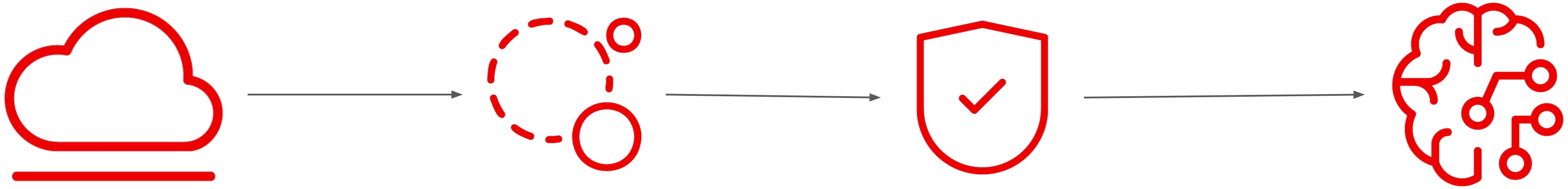
CPT - Cultural shift

- From siloed to **dev + Performance collaboration**
- Embed performance mindset in development sprints
- Performance as part of 'Definition of Done'

Key principles to **navigate change:**

- Document workflows and KPI’s
- Collaboration with QE counterparts is key
  - Handoffs
  - Responsibility matrix

CPT workflow



Deploy product

Run perf test

Store results

Perf regression analysis

Achievements

- Catch performance/scalability regressions in an early stage
- Redefined a new test/platform coverage matrix standard

5 platforms

AWS, Azure, GCP, IBM, Baremetal +
Managed services offerings: ROSA and ARO

+100 weekly tests

Covering nightly, early candidates, release candidates, stable releases and long term support

Platform +

- OpenShift Virtualization
- Layered products (OLS, ACS, Kepler, …)

Tooling - Kube-burner

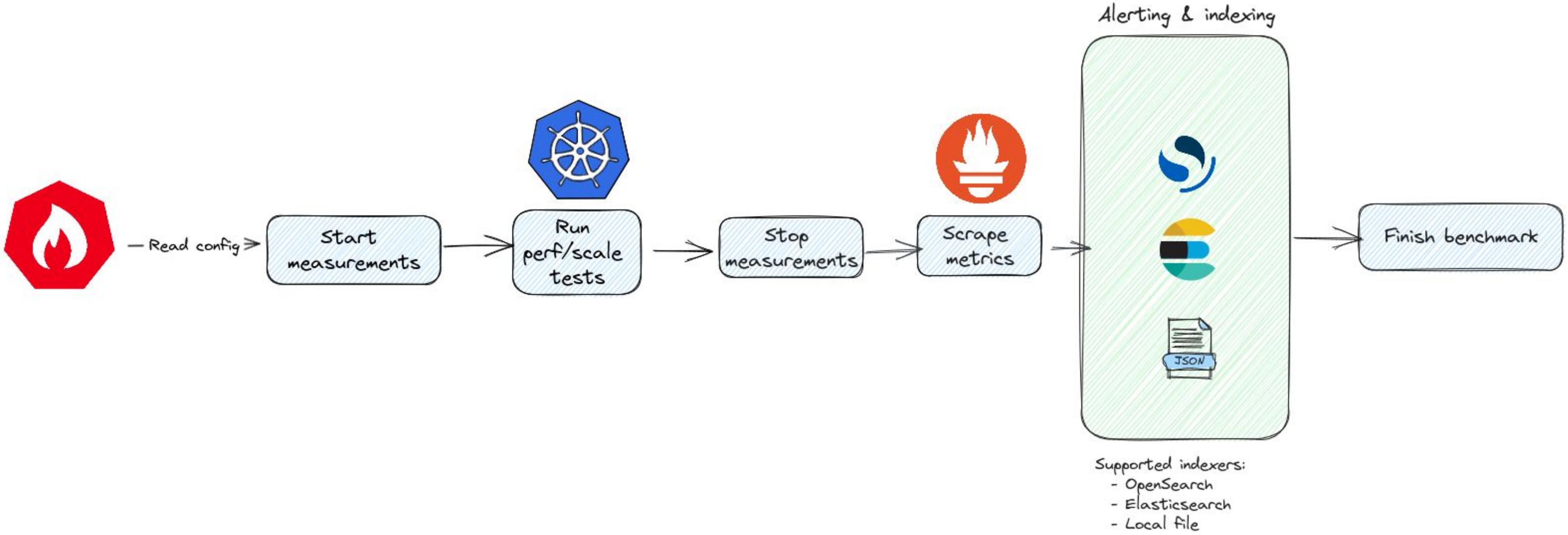
What's this?

Kubernetes **performance and scale test orchestration framework**.

It provides multi-faceted functionality, some most important of which are:

- CRUD operations over Kubernetes resources at scale
- Prometheus metric collection and indexing
- Measurements
- PromQL based alerting

Kube-burner



Supported indexers:
- OpenSearch
- Elasticsearch
- Local file

Kube-burner Highlights

- Configurable API call rate through **QPS/Burst**
- Easy to use, friendly **YAML** based configuration files
- Very flexible configuration, with lots of options and customizations
- Fully compatible with vanilla K8s and other K8s distros
- **Canned workloads** and more customizations can be added through plugins
- **CNCF**'s Sandbox project and currently working on upgrading it to Incubating

Kube-burner jobs

Support for different **job types**

- **Create**: Creates the listed objects
- **Delete**: Deletes objects enumerated in the objects list by using label selectors
- **Patch**: Patches objects with a predefined patch template
- **Read**: Lists objects described in the objects list.
- **Kubevirt**: Can be used to execute virtctl type commands (using kubecli) over running VMs.

Kube-burner observability

- **Prometheus** metrics scraping
  - Collection of Prometheus metrics over the workload runtime
  - Evaluates Prometheus expressions to fire alerts
- **Measurements**
  - Additional observability w/o using Prometheus:
    - Pod/Job/PVC Latency
    - VM/VMI latency (Kubevirt)
    - Pprof
    - And more

Kube-burner alerting

Evaluates Prometheus expressions configured in a file called **alert-profile**.

When the PromQL condition is met kube-burner fires an alert with a defined severity:

- *info*, *warning*, *error* or *critical*

These alerts can be indexed along with the collected metrics or measurement.

In the workloads currently executed within CPT, just a few alerts have an error severity or higher

Kube-burner-ocp

Some of the **supported workloads** are:

- **Cluster-density-v2**: Creates a high number of objects that generate a significative load in the control plane and the CNI plugin. (Deployments, secrets, builds, routes, probes, etc)
- **Node-density**: Fills with pause pods all the worker nodes of the cluster
- **Node-density-cni**: Fills with client/server (curl and nginx) pods sending periodic traffic through services
- **Node-density-heavy**: Fills with client/server (server is a postgresql database), where the client performs performs periodic queries in the database
- **Virt-density**: Spawns a series of tiny VMs across the worker nodes of the cluster
- **Virt-density-udn**: Similar to the previous, but those VMs are configured to use OVN's UDN interfaces.
- **Virt-migration**: Tests how the cluster and the storage backend handles mass migration of VMs

It's all about data - Automatic regression detection

When a benchmark finishes, it doesn't mean a success from a Perf&Scale perspective.

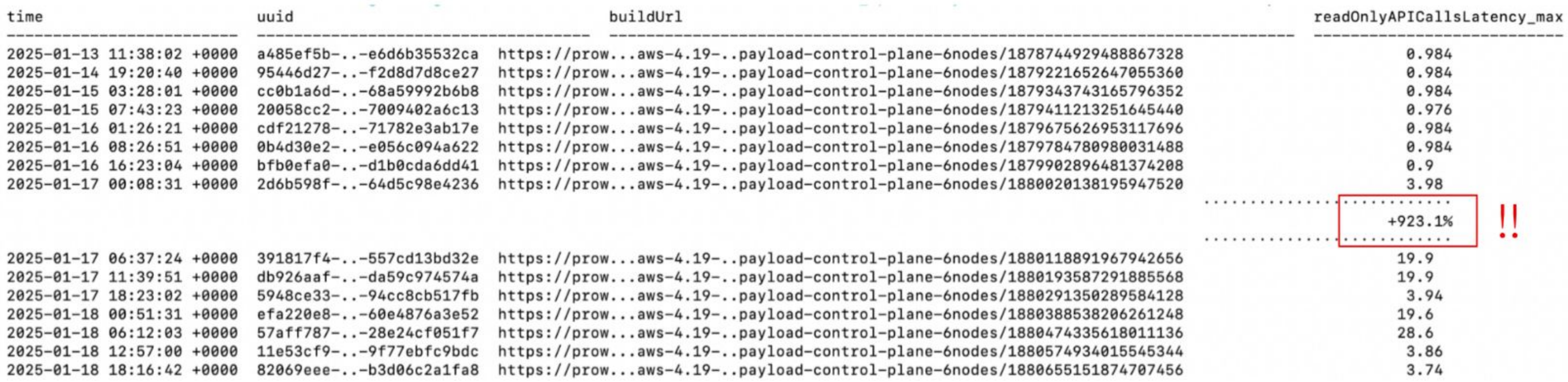
We post-process the benchmark's generated data using our own **regression detection framework**, Orion.

- Uses different algorithms to detect regressions and deviations in some specific metrics we consider reliable and stable.

We've been able to early detect, report and fix (when possible) many performance regressions. i.e:

- A 25% deviation in the pod latency can mean many things, since lots of components are involved in a pod creation
  - We narrow down the issue by snooping around the updated bits in that specific OpenShift build.

Success stories - KAPI latency

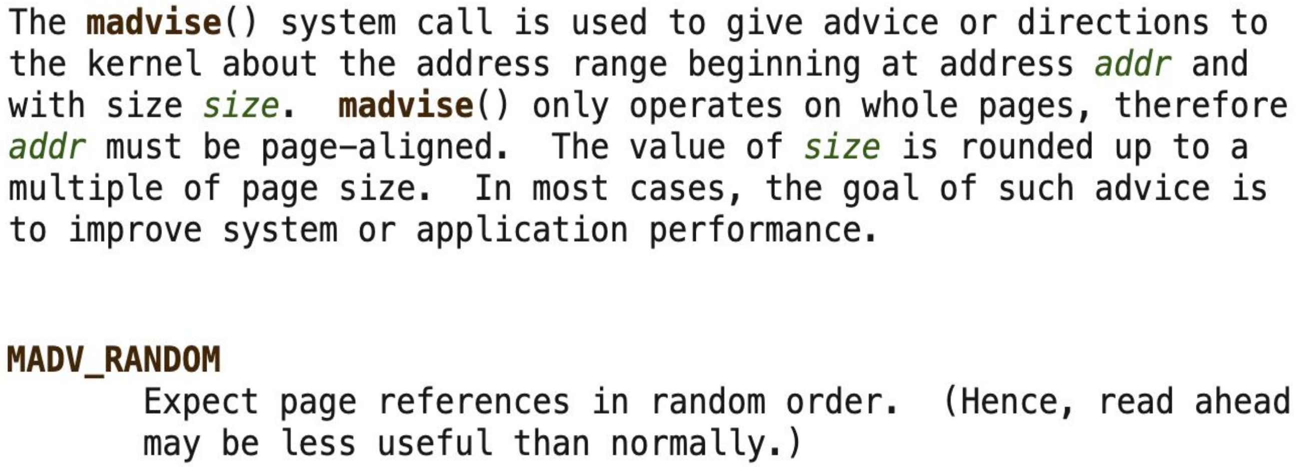


```
time                        uuid                                  buildUrl                                                                    readOnlyAPICallsLatency_max
-------------------------   ------------------------------------  --------------------------------------------------------------------------  ---------------------------
2025-01-13 11:38:02 +0000  a485ef5b-..-e6d6b35532ca  https://prow...aws-4.19-..payload-control-plane-6nodes/1878744929488867328                0.984
2025-01-14 19:20:40 +0000  95446d27-..-f2d8d7d8ce27  https://prow...aws-4.19-..payload-control-plane-6nodes/1879221652647055360                0.984
2025-01-15 03:28:01 +0000  cc0b1a6d-..-68a59992b6b8  https://prow...aws-4.19-..payload-control-plane-6nodes/1879343743165796352                0.984
2025-01-15 07:43:23 +0000  20058cc2-..-7009402a6c13  https://prow...aws-4.19-..payload-control-plane-6nodes/1879411213251645440                0.976
2025-01-16 01:26:21 +0000  cdf21278-..-71782e3ab17e  https://prow...aws-4.19-..payload-control-plane-6nodes/1879675626953117696                0.984
2025-01-16 08:26:51 +0000  0b4d30e2-..-e056c094a622  https://prow...aws-4.19-..payload-control-plane-6nodes/1879784780980031488                0.984
2025-01-16 16:23:04 +0000  bfb0efa0-..-d1b0cda6dd41  https://prow...aws-4.19-..payload-control-plane-6nodes/1879902896481374208                0.9
2025-01-17 00:08:31 +0000  2d6b598f-..-64d5c98e4236  https://prow...aws-4.19-..payload-control-plane-6nodes/1880020138195947520                3.98
                                                                                                                                    .........................
                                                                                                                                                +923.1%
                                                                                                                                    .........................
2025-01-17 06:37:24 +0000  391817f4-..-557cd13bd32e  https://prow...aws-4.19-..payload-control-plane-6nodes/1880118891967942656               19.9
2025-01-17 11:39:51 +0000  db926aaf-..-da59c974574a  https://prow...aws-4.19-..payload-control-plane-6nodes/1880193587291885568               19.9
2025-01-17 18:23:02 +0000  5948ce33-..-94cc8cb517fb  https://prow...aws-4.19-..payload-control-plane-6nodes/1880291350289584128                3.94
2025-01-18 00:51:31 +0000  efa220e8-..-60e4876a3e52  https://prow...aws-4.19-..payload-control-plane-6nodes/1880388538206261248               19.6
2025-01-18 06:12:03 +0000  57aff787-..-28e24cf051f7  https://prow...aws-4.19-..payload-control-plane-6nodes/1880474335618011136               28.6
2025-01-18 12:57:00 +0000  11e53cf9-..-9f77ebfc9bdc  https://prow...aws-4.19-..payload-control-plane-6nodes/1880574934015545344                3.86
2025-01-18 18:16:42 +0000  82069eee-..-b3d06c2a1fa8  https://prow...aws-4.19-..payload-control-plane-6nodes/1880655151874707456                3.74
```

!!

Success stories - KAPI latency

- Focus on one single build containing **618 commits** (!)
- Kernel team took bisection down through all commits to land on a single (or two) change(s)

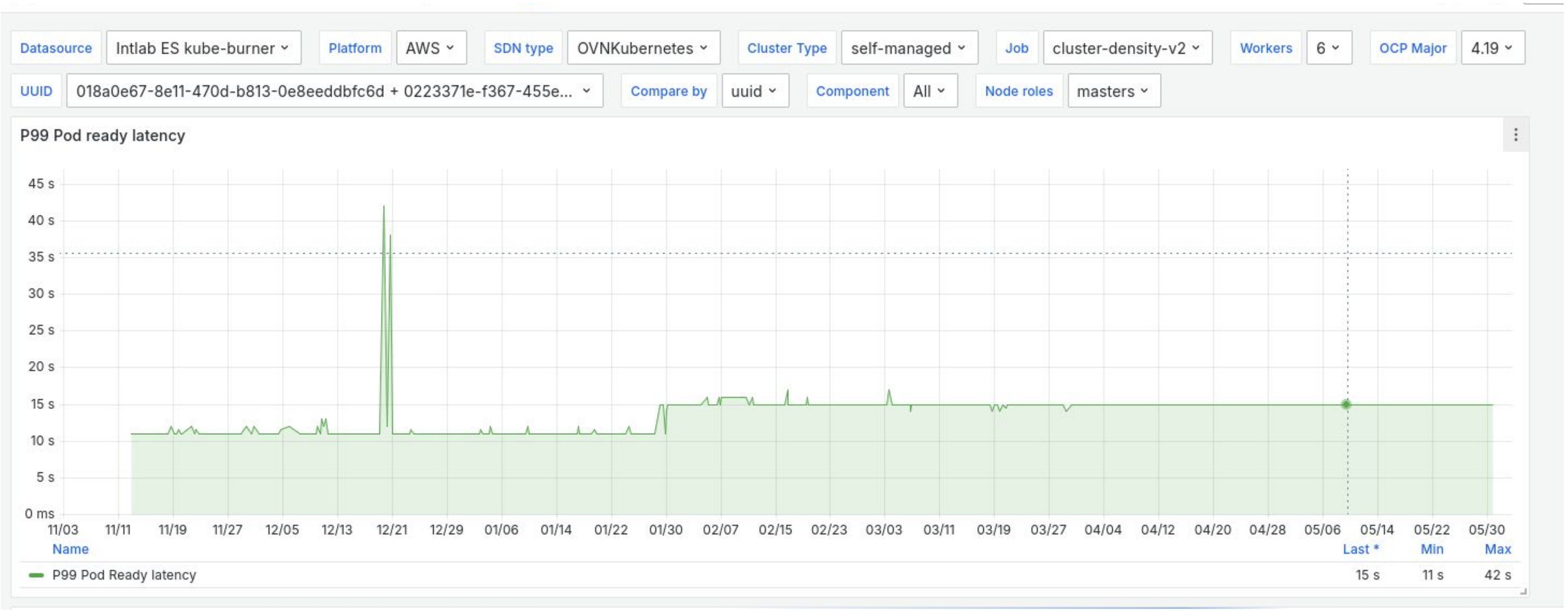


```
The madvise() system call is used to give advice or directions to
the kernel about the address range beginning at address addr and
with size size.  madvise() only operates on whole pages, therefore
addr must be page-aligned.  The value of size is rounded up to a
multiple of page size.  In most cases, the goal of such advice is
to improve system or application performance.


MADV_RANDOM
       Expect page references in random order.  (Hence, read ahead
       may be less useful than normally.)
```

Success stories - Pod Latency

- Focus on a specific Pull Request containing **2839 commits** (!)
- Git **bisect**, recompile kubelet and run test to find out the specific "**bad commit**"



Datasource: Intlab ES kube-burner
Platform: AWS
SDN type: OVNKubernetes
Cluster Type: self-managed
Job: cluster-density-v2
Workers: 6
OCP Major: 4.19
UUID: 018a0e67-8e11-470d-b813-0e8eeddbfc6d + 0223371e-f367-455e...
Compare by: uuid
Component: All
Node roles: masters

P99 Pod ready latency

Name	Last *	Min	Max
P99 Pod Ready latency	15 s	11 s	42 s

Kube-burner-ocp demo

More **demos** at https://github.com/kube-burner/kube-burner-demos

Challenges

- Resistance to change and lack of expertise
- Tooling integration issues
- We can only detect regressions on metrics we are tracking
- Avoid **duplicated testing**
  - Reduce redundant tested combinations
- Enable developers to **interpret** (and predict) performance results
  - Exploring the use of AI to help* analyze results

Solutions

Key principles to **navigate change**:

- Training
- Automation
- Establish a solid protocol for dealing with test failures and flakiness
- Champion roles

Roadmap - where to start

- **Start with one service**
- Educate teams on performance fundamentals
- Build integrated performance dashboards into CI/CD pipelines
- Include performance in code reviews

Food for thought:

- How can performance testing fit into your current sprint workflow?
- What’s one thing you could shift left today?

Wrap up

1. Shift-left engineering
2. Continuous Performance Testing (CPT)
3. Workflow
4. Tooling
    a. kube-burner
5. Real life case study
    a. OCP → CoreOS → Kernel → syscall
6. Challenges and next steps

Q&A