Kubernetes Workload Resiliency in Action - Beyond Basics

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It can run.

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Can it run reliably?

BEFORE WE START

Three questions for the room

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? Who has lost a long job to an eviction?

? Who shares one cluster across many teams?

Story Time

Kubernetes is becoming

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THE OS for AI

THE GAP BETWEEN

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66%

can run it

THE GAP BETWEEN

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66%
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7%
deploy daily

— CNCF 2025 Annual Survey

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The stakes are loud in AI. The fix is universal.

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UNIVERSAL FIX

The mechanisms that fix it protect **any** workload, in **any** production cluster, today.

THE REAL LESSON

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No single mechanism is enough.

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Resilience is how you layer them.
The interactions are where teams break.

THE RESILIENCE STACK

Resilience is a stack, not a setting.

Scheduler + Kubelet

↓ foundation

THE RESILIENCE STACK

Resilience is a stack, not a setting.

Requests / Limits + QoS

PriorityClass

ResourceQuota

PodDisruptionBudget

Affinity + RuntimeClass

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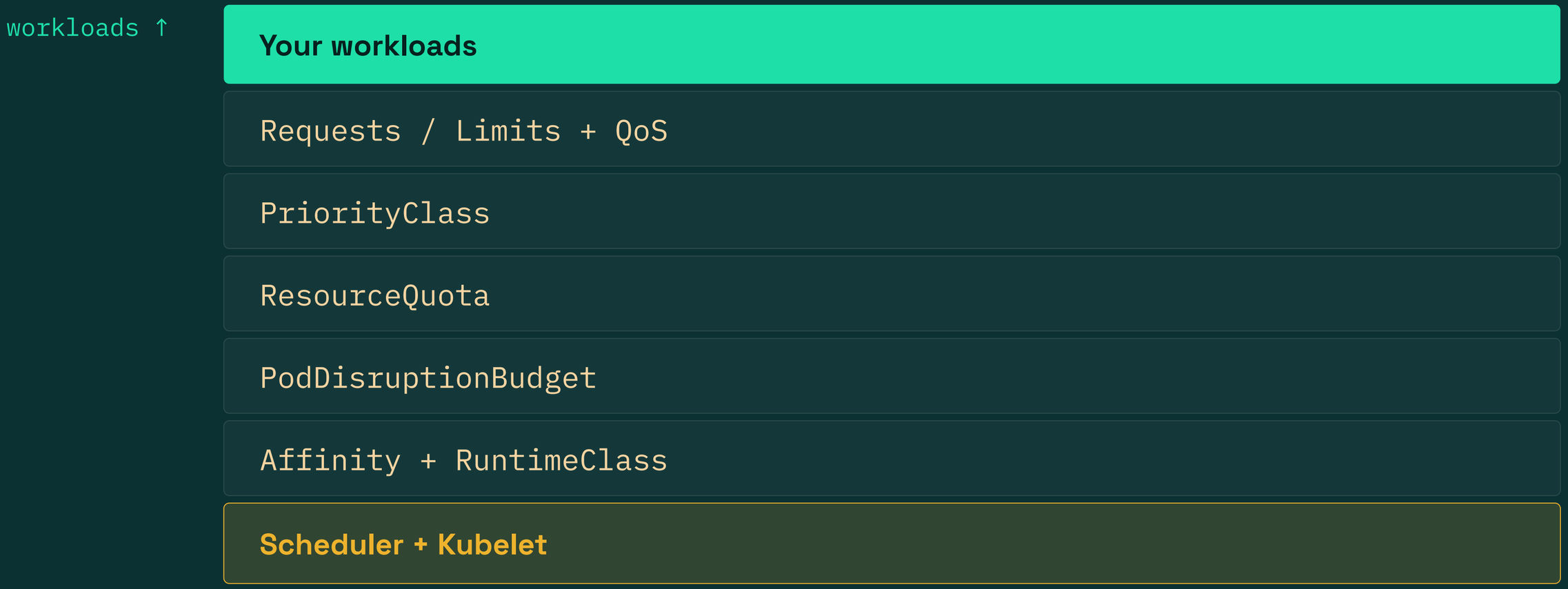

THE PLAN

Where the next thirty minutes go.

01 3 workloads, 3 failure shapes	02 The 6 levers each one pulls	03 How the levers interact	04 Where it all breaks at scale

STORY 1

Training that must not break.

The long-running workload pattern

STORY 1 · THE SHAPE OF THE PROBLEM

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- **Long-running:** hours to days on scarce accelerators.
- **Gang-scheduled:** every rank runs, or none make progress.
- An interruption wastes **everything** since the last checkpoint.

STORY 1 · THE LEVERS

Four levers. PDB is the hero.

`PriorityClass`	don’t preempt training for low-value work
`PodDisruptionBudget`	**turn a hard kill into a graceful drain, so the job checkpoints**
`Grace + preStop`	actually use that drain window to checkpoint
`Gang + topology`	place ranks together, or hold GPUs for nothing

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THE KILLER STAT

5 of 6 ranks

= 0% progress

83% of GPUs held, doing nothing.

`At scale: 400 / 512 bound, 112 pending → 400 GPUs idle`

REFERENCE

developer.nvidia.com

AI Workloads on Rack-Scale Supercomputers

From hardware to topology-aware scheduling.

TAKE IT HOME

A PDB is how a training job survives the cluster doing its job.

Drains, upgrades, normal maintenance.
Go check yours! Most jobs don't have one.

STORY 2

Inference that stays up

Mission-critical services

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A warm KV cache means ”just restart it” isn’t free.

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STORY 2 · WHAT IT DEMANDS

Three demands the demo never tests.

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Elastic scaling pods **and** nodes — HPA/KEDA + Cluster Autoscaler/Karpenter	**Low latency** held steady under bursty load, not just at rest	**Automated failover** no human in the loop when a replica dies

STORY 2 · THE LEVERS

Same shape.
Graceful degradation is the idea.

`Requests/Limits + QoS`	Guaranteed for latency-critical serving
`PriorityClass`	graceful degradation - shed batch before interactive
`PodDisruptionBudget`	hold minimum replicas through disruptions
`DRA + RuntimeClass`	GPU allocation. Isolation where serving needs it

STORY 2 · THE KEY INTERACTION

Under node pressure - who gets evicted first?

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THE TRAP

A high-priority BestEffort pod dies before a low-priority Guaranteed pod.

QoS is checked first, **then** priority. Priority is not a force field.

STORY 2 · ECOSYSTEM

Where inference work now lives.

Gateway API Inference Extension

Kueue · elastic workloads

NVIDIA Grove

WG Serving concluded · Feb 2026 →

autoscaling → SIG Node / Scheduling

multi-host (LWS) → SIG Apps

DRA → WG Device Management

STORY 3

Multi-tenancy: one cluster, many teams

Shared clusters

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One tenant bin-packs to the edge, the rest starve.

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STORY 3 · THE LEVERS

Two jobs: fairness and isolation.

`ResourceQuota`	fair caps per tenant, scoped by PriorityClass
`PriorityClass`	system components outrank every tenant
`RuntimeClass`	isolate untrusted or specialized workloads
`Affinity/spread/taints`	carve pools, spread replicas for blast radius

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STORY 3 · THE INTERACTION

Quota is a dial, not a switch.

too tight →	balance point	← too loose
legitimate jobs sit **Pending**	scope **by PriorityClass** : generous for prod, tight for dev	one tenant **hoards** the pool

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You can’t give the OS a PriorityClass. You reserve for it.

STORY 3 · SPECIALIZED CASE — HPC & SCIENTIFIC COMPUTING

The failure is silent: no error, just slower every run.

- Tightly coupled MPI / collective jobs.
- Performance dominated by interconnect and NUMA / device locality.
- Topology Manager (NUMA alignment), gang scheduling, DRA + ComputeDomains for multi-node NVLink.

THE TOOLBOX · SIX LEVERS

What each really does

LEVER	WHAT IT ACTUALLY CONTROLS	COMMON MISREAD
`Requests/Limits + QoS`		*”limits = guarantee”*
`PriorityClass`		*”scheduled first”*
`ResourceQuota`		*”per-user”*
`RuntimeClass`		*”only for sandboxing”*
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`Affinity / topology spread`	placement + spreading	*”scheduler reads my mind”*

MATCH THE LEVER TO THE WORKLOAD'S LIFE

Anchored and protected vs disposable and retryable.

	Long-running (training, serving)	**Ephemeral** (batch, Jobs)
Disruption	PDB, checkpoints	preemptible, just retry
Placement	anti-affinity, spread	pack, backfill
QoS	Guaranteed / Burstable	Burstable / BestEffort

WHERE IT BREAKS

Three failure modes

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At scale, the abstractions leak

Three failure modes

FAILURE MODE 1 · EVICTIONS

Push the node past the edge, the accounting bites.

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Fixed upstream. We hit it at scale before it was.

FAILURE MODE 2 · PERFORMANCE DEGRADATION

The scariest failures don’t page you. They tax you.

- NUMA / topology misalignment costs you on every run.
- No error, no alert, just slower.
- Topology Manager is opt-in. Off by default

AT 8 NUMA NODES

>4.2B

hint combinations

~21 min to schedule

k8s #131738

FAILURE MODE 3 · CASCADING FAILURES

One node tips the next, which is also at the edge.

node A

system starved → dies

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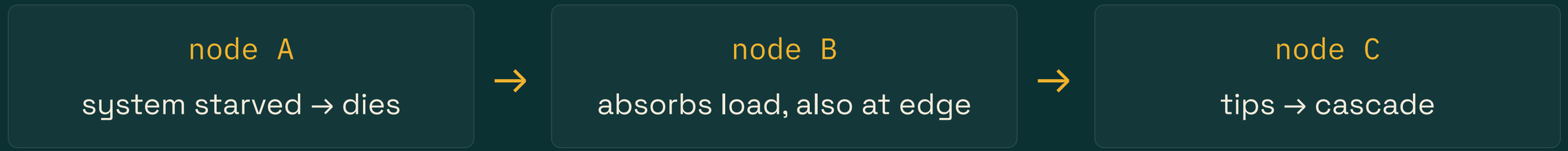

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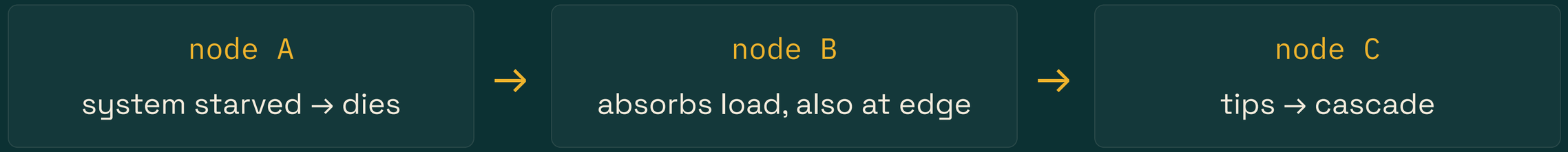

Reserve node headroom before you pack, not after.

It can run.

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Now make it run reliably.

TAKE THIS HOME

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- Protect the cluster’s own components first.
- The skill is the **interactions**, not the settings.
- PDBs turn maintenance from outage into a non-event.

GO LOOK. TODAY.

Three checks that find real gaps.

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? Do your long-running jobs have **PDBs**?

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? Do your latency-critical pods have **Guaranteed QoS**?

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Three checks that find real gaps.

? Do your long-running jobs have **PDBs**?

? Do your latency-critical pods have **Guaranteed QoS**?

? Do your system daemons **outrank** user workloads?

KubeCon CloudNativeCon India 2026

Thank you

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Questions?

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