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CON324

Optimizing Amazon EKS for performance and cost on AWS

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Agenda

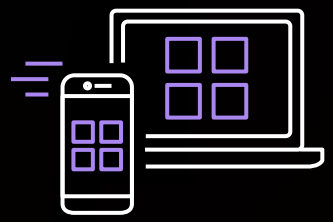
- What is Amazon EKS?
- Kubernetes cost optimization challenges
- Getting to granular cost visibility in Kubernetes
- Optimizing Compute Costs with AWS Graviton
- Optimizing Compute Costs with EC2 Spot
- Automatically Optimizing Compute Costs with Karpenter
- Wrapping up

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What is Amazon EKS?

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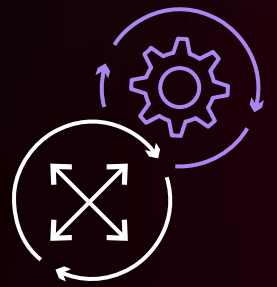
What do our customers want?



Get to
market faster



Lower total cost
of ownership



High performance
and scalability



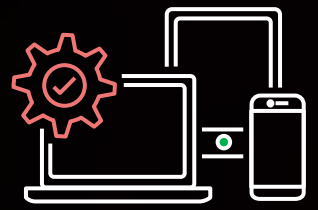
Security and
isolation by design

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What is Amazon EKS?



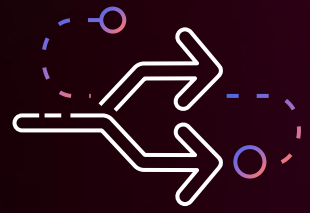
Security first



Built for production



Seamless cloud integrations



Native and upstream

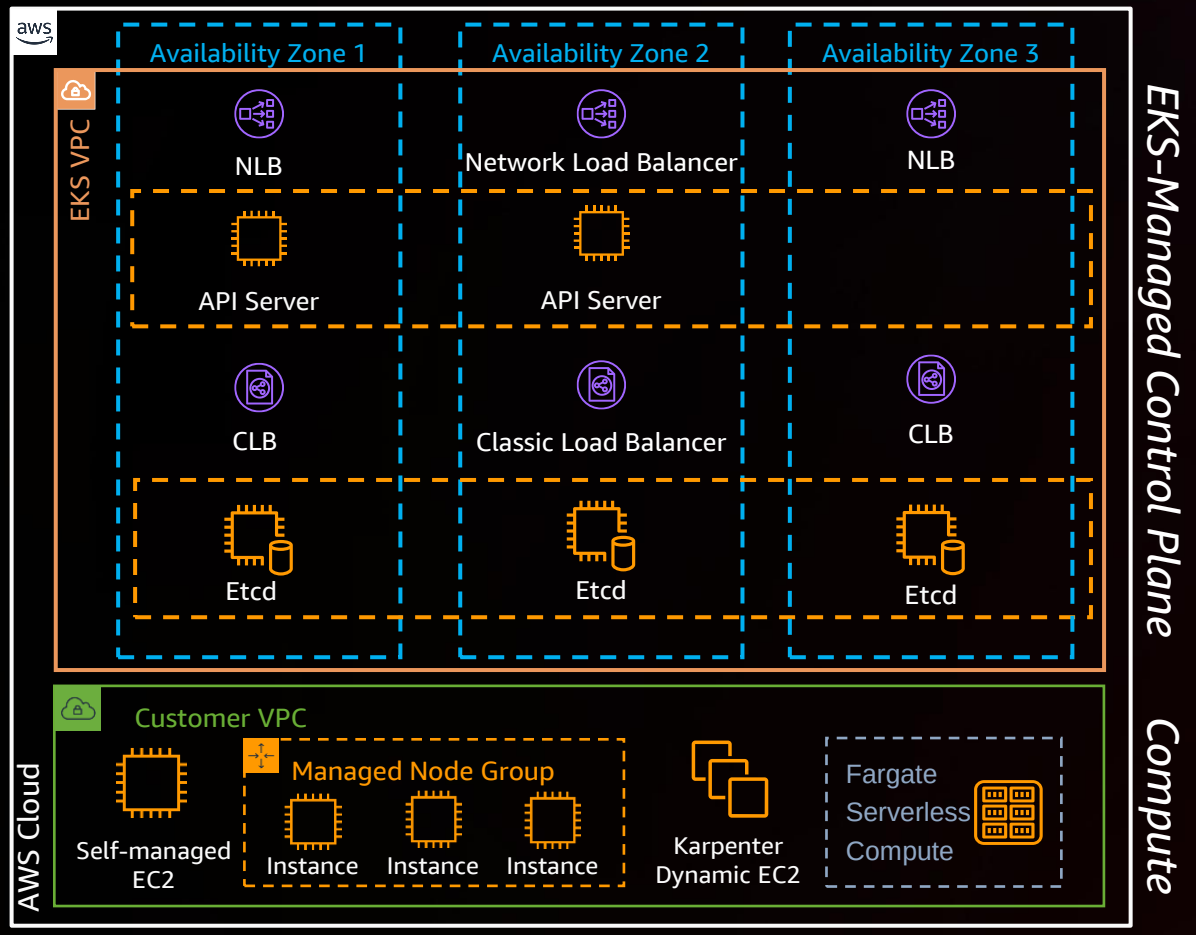


Committed to open source

AWS makes it easy to run Kubernetes; Amazon EKS helps you build reliable, secure, and efficient applications in virtually any environment.

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What does an Amazon EKS cluster look like?



AWS managed control plane

- **Highly available, single-tenant Kubernetes API server and etcd database**

Cluster compute

- **Self-managed EC2 instances**
  Run in your account, customer managed, maximum flexibility/configurability
- **EKS managed nodes**
  Run in your account, AWS-managed provisioning and instance lifecycle
- **Karpenter**
  Customer-managed, cutting edge, open-source node provisioning and cluster autoscaling
- **AWS Fargate**
  Serverless, right-sized compute; AWS-managed OS, container runtime; storage/monitoring plugins; granular, pod-based billing

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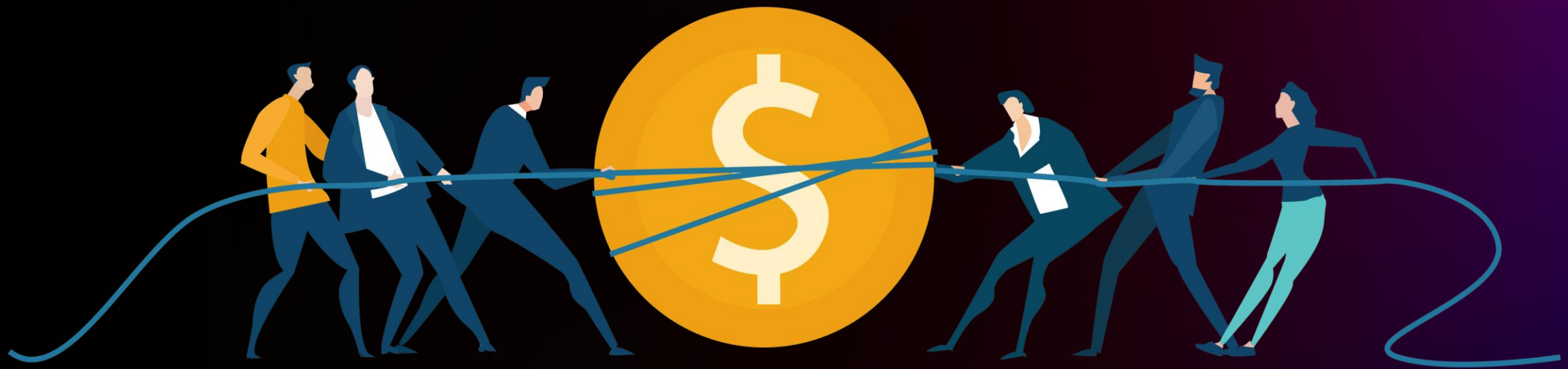
Kubernetes cost optimization challenges

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Fundamental cost and performance tension

COST AND PERFORMANCE IN KUBERNETES

Striking the right balance between minimizing costs and achieving performance and/or availability SLOs is hard



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Customer cost challenges

COST AND PERFORMANCE IN KUBERNETES



Allocate costs across teams and departments



Chargeback/showback



Reporting, budget forecasting, and cost optimization

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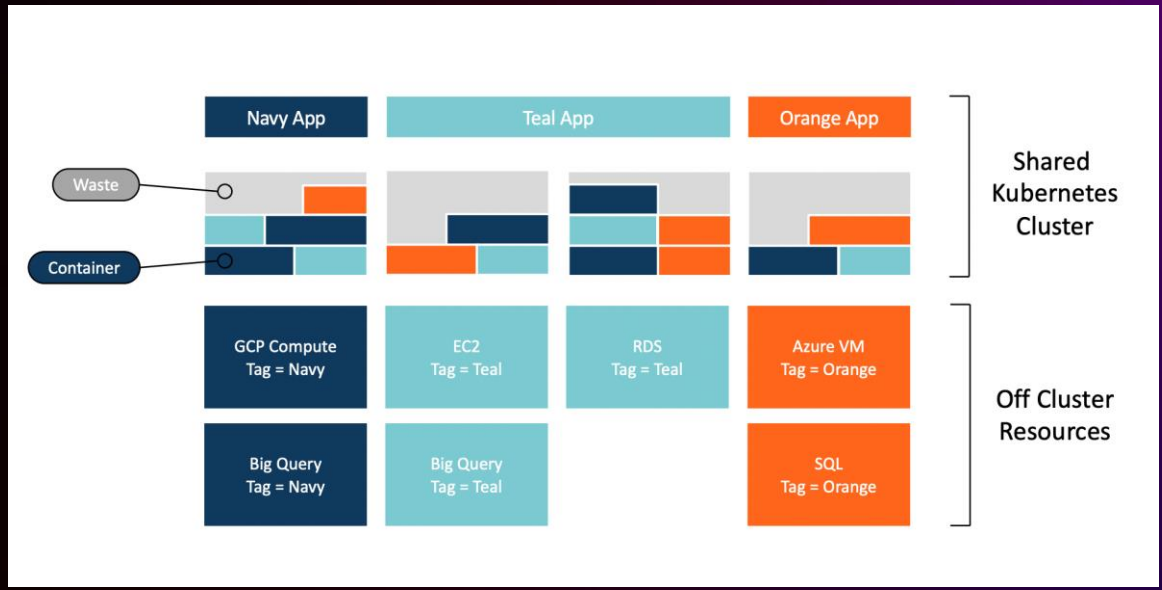
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Kubernetes increases the difficulty

COST AND PERFORMANCE IN KUBERNETES

Short pod lifecycles, shared resources mean

- **Fewer than 66%** of organizations have detailed Kubernetes cost monitoring
- **Only 22%** of organizations surveyed are able to accurately predict their Kubernetes costs with 5% accuracy or better



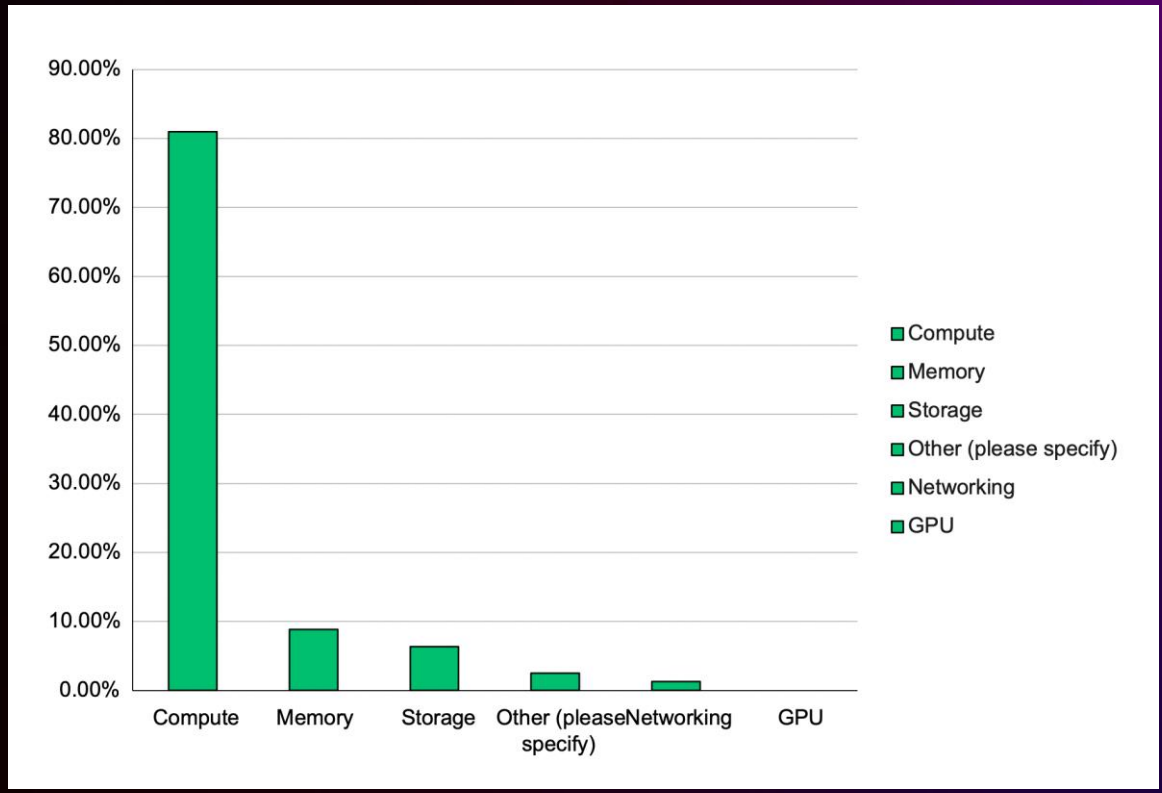
Source: FinOps for Kubernetes by FinOps Foundation

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Kubernetes cluster cost drivers

COST AND PERFORMANCE IN KUBERNETES

1. Cluster compute and memory, >90%
    a. Applications
    b. Under utilized resources
    c. Kubernetes overhead, daemonsets, and so on
2. Cluster storage and networking
3. Third-party software licenses
4. Managed Kubernetes control plane



Source: FinOps for Kubernetes by FinOps Foundation

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FinOps Cycle

COST AND PERFORMANCE IN KUBERNETES

Inform

Detailed visibility into Kubernetes spend enables accurate chargeback and showback.

Optimize

Once informed, leverage all available mechanisms to improve utilization and lower costs

Operate

Continuously evaluate business goals and update metrics tracked



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Getting to granular cost visibility in Kubernetes

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Layers of cost visibility: Single-tenant clusters

GETTING TO GRANULAR COST VISIBILITY

- Each application or team gets an entire cluster
- As number of clusters grow, giving each its own AWS account is unrealistic
- Although EC2 instances and other resources aren’t shared between clusters, can be hard to breakout EC2 costs by cluster within a single AWS account

Amazon EKS adds cost allocation tags to all EC2 instances in an EKS cluster by default

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Layers of cost visibility: Multi-tenant clusters

GETTING TO GRANULAR COST VISIBILITY

- Multi-tenant clusters shared by multiple applications and/or teams are common
- Visibility into shared and non-shared resources, for example Amazon RDS databases, is more challenging than in single-tenant clusters and requires
    - Consistent and robust Kubernetes label/tag strategy
    - Utilization monitoring and unused resource cost allocation model
    - Applications to deeply understand requirements and use resource requests

Amazon EKS partnered with Kubecost to provide licensed features at no additional cost

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Now Available!

Kubecost for granular cost visibility

GETTING TO GRANULAR COST VISIBILITY



Amazon **EKS** + kubecost

- Kubecost provides real-time cost visibility and insights for Kubernetes, helping you continuously reduce your EKS cluster costs
- Amazon EKS customers get licensed Kubecost features at no additional cost
  - Granular cost visibility by Kubernetes namespace, deployment, pod, or other resource
  - Support included

Deploy Kubecost directly to your EKS clusters from the AWS Marketplace

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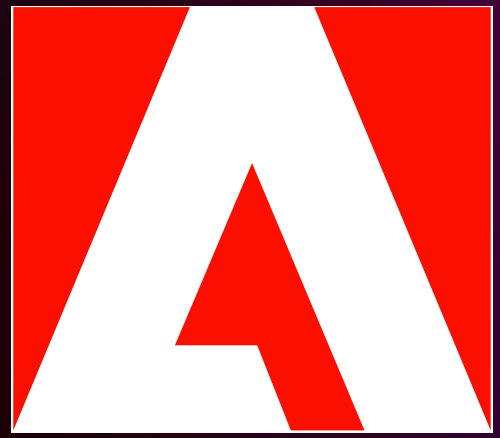
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How Adobe improved cost visibility in EKS

GETTING TO GRANULAR COST VISIBILITY

Adobe's Ethos platform powers their Document, Creative, and Experience Cloud products

- Runs hundreds of multi-tenant clusters across multiple AWS Regions
- Together, these clusters have thousands of namespaces which are used by individual teams
- Use combination of Kubecost and Kubernetes labels to chargeback to teams and power executive dashboards



Adobe







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What to do with this cost information?

GETTING TO GRANULAR COST VISIBILITY

Inform

Detailed visibility into Kubernetes spend enables accurate chargeback and showback.

Optimize

Once informed, leverage all available mechanisms to improve utilization and lower costs

Operate

Continuously evaluate business goals and update metrics tracked to



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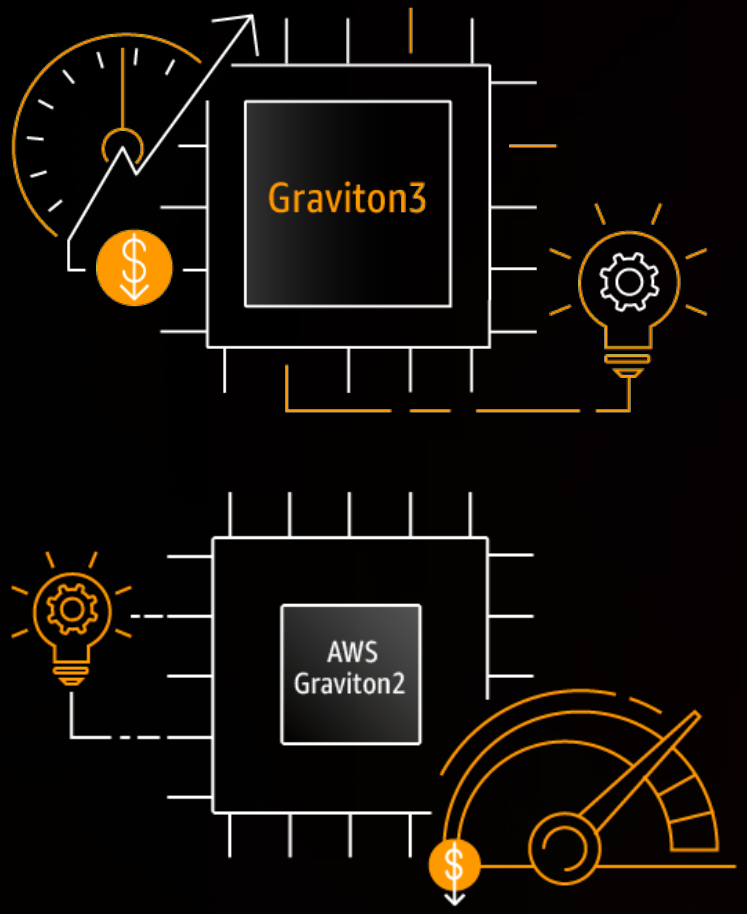
Optimizing Kubernetes Compute Costs, part 1

AWS Graviton

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What is AWS Graviton?

OPTIMIZING KUBERNETES COMPUTE WITH AWS GRAVITON



Custom AWS silicon with 64-bit Arm processor cores

Targeted optimizations for cloud-centered workloads

Rapidly innovate, build, and iterate on behalf of customers

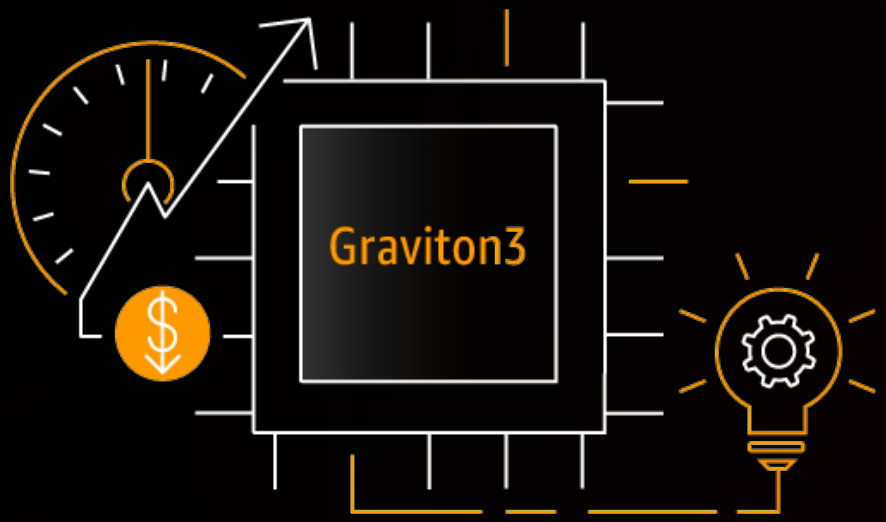
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AWS Graviton3

OPTIMIZING KUBERNETES COMPUTE WITH AWS GRAVITON



Up to 25% better performance compared to Graviton2

Up to 2x higher floating-point, cryptographic performance, and up to 3x better ML performance compared to Graviton2

60% more energy efficient over comparable EC2 instances

C7g instances provide the best price performance for compute-intensive workloads

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How to use AWS Graviton with Amazon EKS

OPTIMIZING KUBERNETES COMPUTE WITH AWS GRAVITON

Amazon EKS managed node groups

```
apiVersion: eksctl.io/v1alpha5
kind: ClusterConfig
metadata:
  name: eks-graviton-cluster
  region: us-west-2
managedNodeGroups:
  - name: mng-arm-c7
    instanceType: c7g.xlarge
    desiredCapacity: 2
```

Amazon EKS with Karpenter

```
apiVersion: karpenter.sh/v1alpha5
kind: Provisioner
metadata:
  name: default
spec:
  requirements:
    - key: "kubernetes.io/arch"
      operator: In
      values: ["arm64"]
```

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AWS Graviton and Amazon EKS considerations

OPTIMIZING KUBERNETES COMPUTE WITH AWS GRAVITON

Remember: Application programming language and its ecosystem need to be multi-architecture aware, for example Go, Rust

- AWS Graviton requires ARM compatible container images, ideally multi-architecture (ARM64 and AMD64) so that you can mix and match Graviton and x86 instance types
- Multi-architecture container images are fully supported on Amazon Elastic Container Registry (ECR) through Docker manifest lists which can be used just like Amazon ECR images in pod specs

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Snap uses AWS Graviton

OPTIMIZING KUBERNETES COMPUTE WITH AWS GRAVITON

"We get to use new innovations from AWS like Graviton and reduce cost, create better performance for our customers."



Jerry Hunter

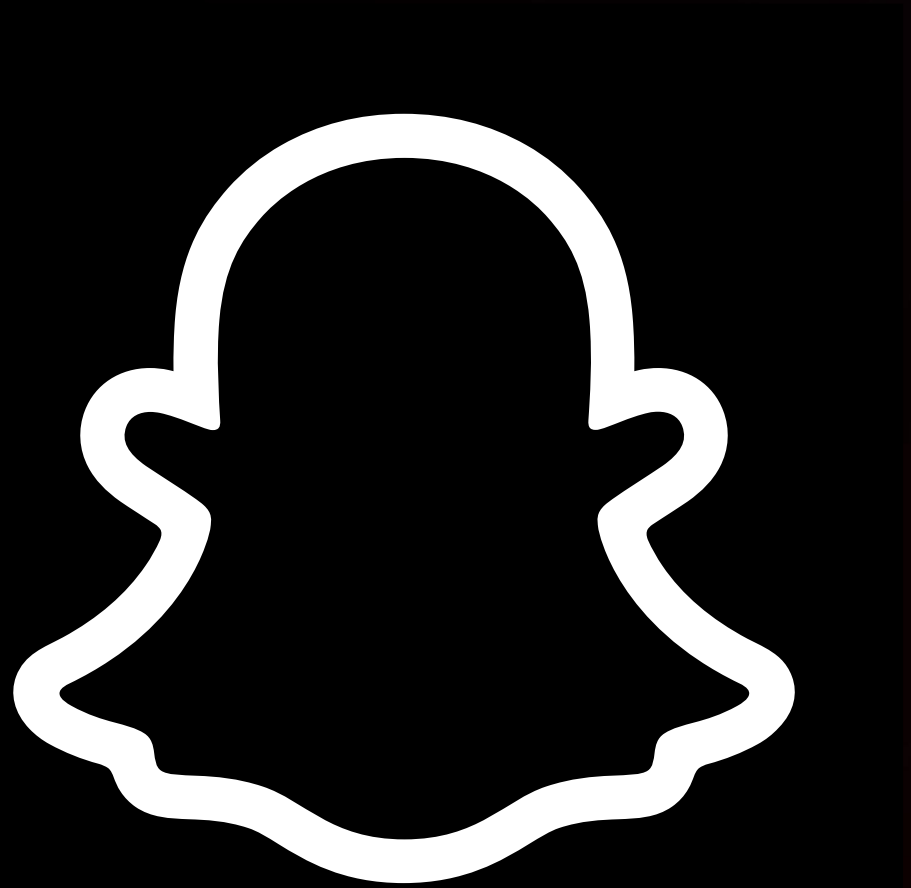
SVP Engineering, Snap Inc.

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Snap uses AWS Graviton with Amazon EKS

OPTIMIZING KUBERNETES COMPUTE WITH AWS GRAVITON



"Snap uses Kubernetes to solve the problems of managing a large set of services, and EKS is helping them to run over 2 million TXs per second. Through EKS and ECR, Snap has realized a 77% reduction in developer effort for launching new microservices."

Karl D'Adamo

Sr. Director of Engineering, Snap Inc.

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Optimizing Kubernetes Compute Costs, part 2

EC2 Spot

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What is EC2 Spot?

OPTIMIZING KUBERNETES COMPUTE WITH EC2 SPOT

Infrastructure

Spare EC2 Capacity



Same capacity as On-Demand and Reserved Instances

Pricing

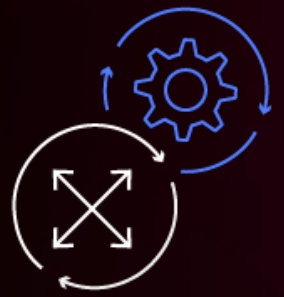
Up to 90% off On-Demand



Based on long-term supply & demand, smoother, more predictable

Interruption

Interrupted in OD needs capacity



Instances can be interruption with a 2 minute warning if needed for On-Demand

Diversification

and flexibility are key



Make use of different instance types, sizes, and Availability Zones

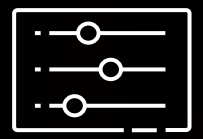
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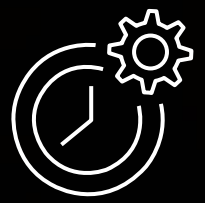
Amazon EKS and EC2 Spot best practices

OPTIMIZING KUBERNETES COMPUTE WITH EC2 SPOT

Diversity and flexibility



Maximizing diversity across instance types, sizes, and availability zones increases Spot availability, decreases interruptions

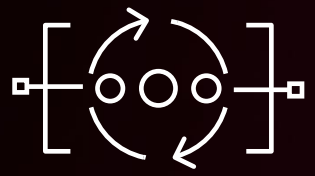


”Time-flexible” workloads are also great Spot candidates as they can wait for available Spot capacity during off-peak hours

Tolerate interruptions



Spot should only be used for short-lived, interruptible workloads. Avoid for long-running jobs or stateful workloads



Both Amazon EKS managed node groups and Karpenter include built-in support for Spot interruption handling

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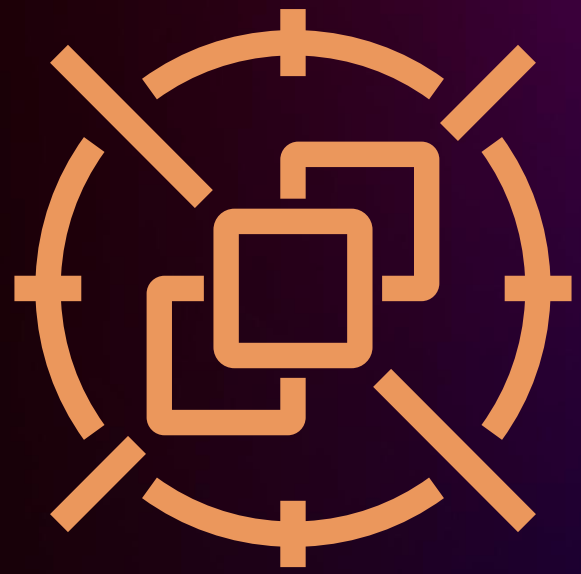
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Price and capacity optimized

OPTIMIZING KUBERNETES COMPUTE WITH EC2 SPOT

New **Price and Capacity Optimized** EC2 Spot allocation strategy available by **default in Karpenter v0.19.0+**

- Best choice for most Spot use cases, including Kubernetes workloads
- Chooses Spot instances to launch based on both spare capacity and Spot Instance price
- Maintains interruption rate similar to Capacity Optimized with lower total cost



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How to use EC2 Spot with Amazon EKS

OPTIMIZING KUBERNETES COMPUTE WITH AWS GRAVITON

Amazon EKS managed node groups

```
apiVersion: eksctl.io/v1alpha5
kind: ClusterConfig
managedNodeGroups:
  - name: mng-spot-4vcpu-16gb
    desiredCapacity: 2
    spot: true
    instanceTypes:
      - m4.xlarge
      - m5.xlarge
      ...
    taints:
      - key: faultTolerant
        effect: NoSchedule
```

Amazon EKS with Karpenter

```
apiVersion: karpenter.sh/v1alpha5
kind: Provisioner
spec:
  requirements:
    - key: karpenter.sh/capacity-type
      operator: In
      values: ["spot"]
    - key: karpenter.k8s.aws/instance-size
      operator: NotIn
      values: [nano, micro, small, medium]
  taints:
    - key: faultTolerant
      effect: NoSchedule
```

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Airtel uses EC2 Spot and Amazon EKS

OPTIMIZING KUBERNETES COMPUTE WITH EC2 SPOT

Wynk Studio Use Case

Wynk studio is an “over-the-top” media platform for independent artists and podcasters to publish and promote their content

- Streams 1TB of data per minute using AWS
- Traffic increases by 2-4x in seconds
- Reliability is crucial to their customers



Airtel achieved 47% cost optimization by adopting EC2 Spot instances across their production and non-production environments

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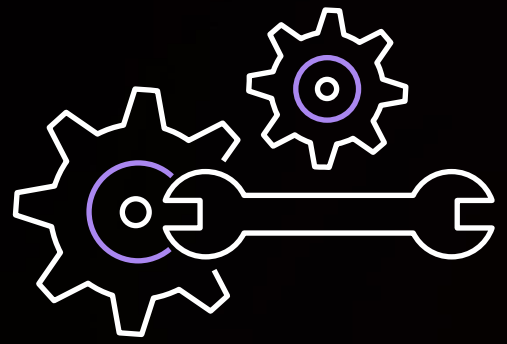
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Automatically Optimizing Kubernetes Compute Costs with Karpenter

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Karpenter – Intelligent Compute for Kubernetes

AUTOMATICALLY OPTIMIZING KUBERNETES COMPUTE COSTS WITH KARPENTER



Karpenter is an **intelligent** and **high-performance** Kubernetes compute provisioning and management solution



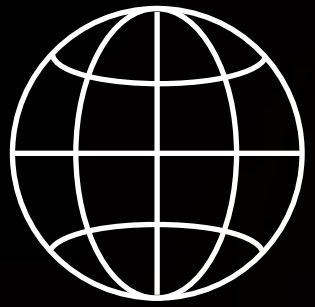
Karpenter lets you take **full advantage of AWS** with its deep integration between Kubernetes and Amazon EC2

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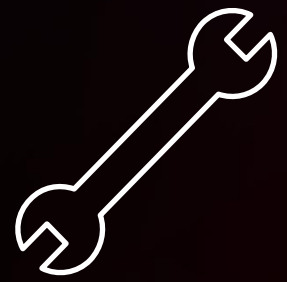
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Why Karpenter?

AUTOMATICALLY OPTIMIZING KUBERNETES COMPUTE COSTS WITH KARPENTER



Responds in seconds when application load changes, **improving availability**



Kubernetes-native CRDs enable GitOps workflows and **minimize operational overhead**



Intelligently chooses instance types and consolidates pods to **lower compute costs**

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Lowering compute costs with Karpenter

AUTOMATICALLY OPTIMIZING KUBERNETES COMPUTE COSTS WITH KARPENTER

- Intelligent and dynamic instance type selection
- Automatic workload consolidation feature
- Kubernetes-native integrations with AWS compute services and features, for example **EC2 Spot** and **AWS Graviton**
- Consistently faster node launches to minimize wasted time/cost
- Lower operational overhead, customers can focus on delivering value

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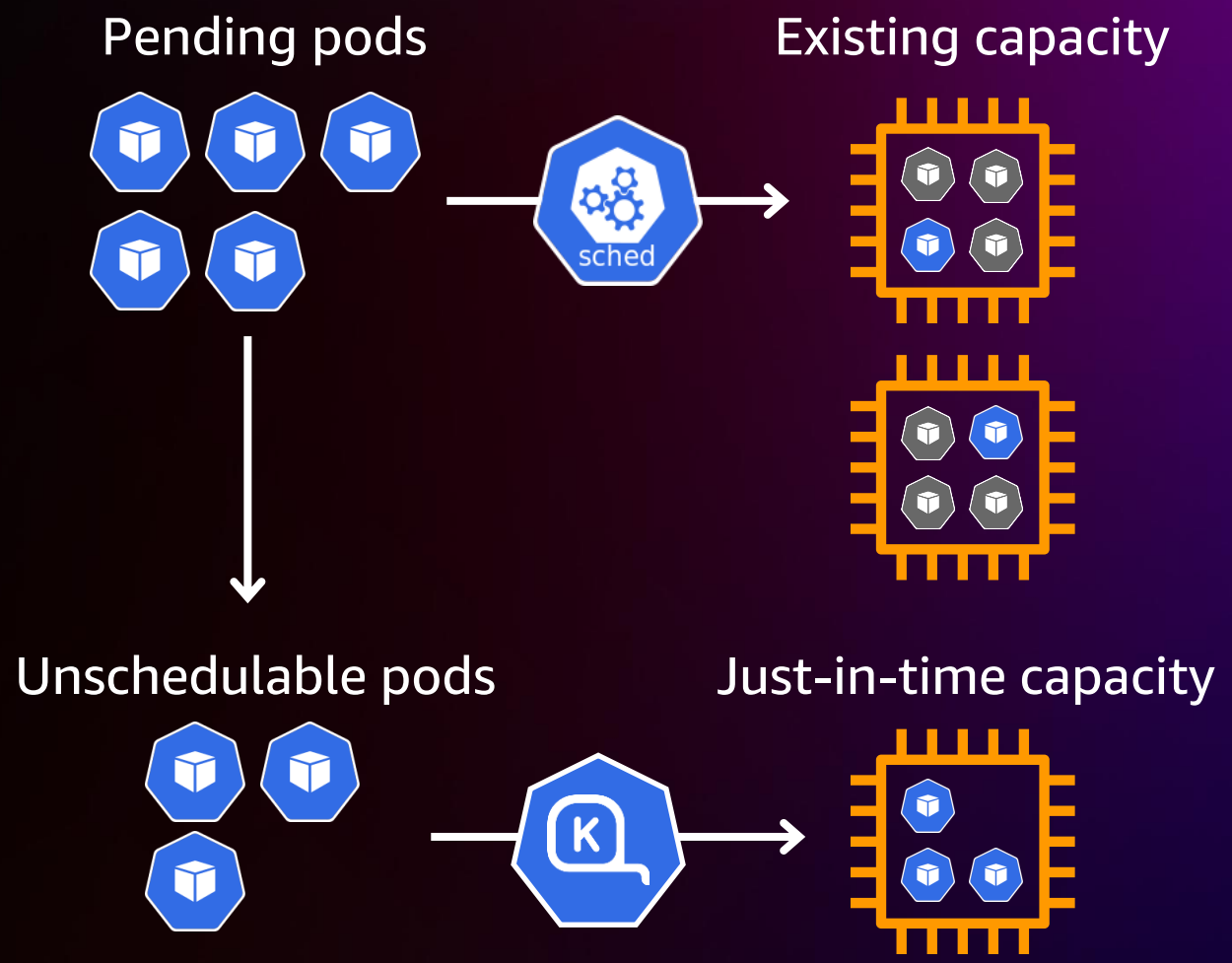
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How Karpenter works

AUTOMATICALLY OPTIMIZING KUBERNETES COMPUTE COSTS WITH KARPENTER

Karpenter works in **tandem with the Kubernetes scheduler** and your compute provider to

- Dynamically choose and launch best-suited compute resources
- Terminate underutilized nodes
- Use Kubernetes-native scheduling constraints to achieve availability requirements



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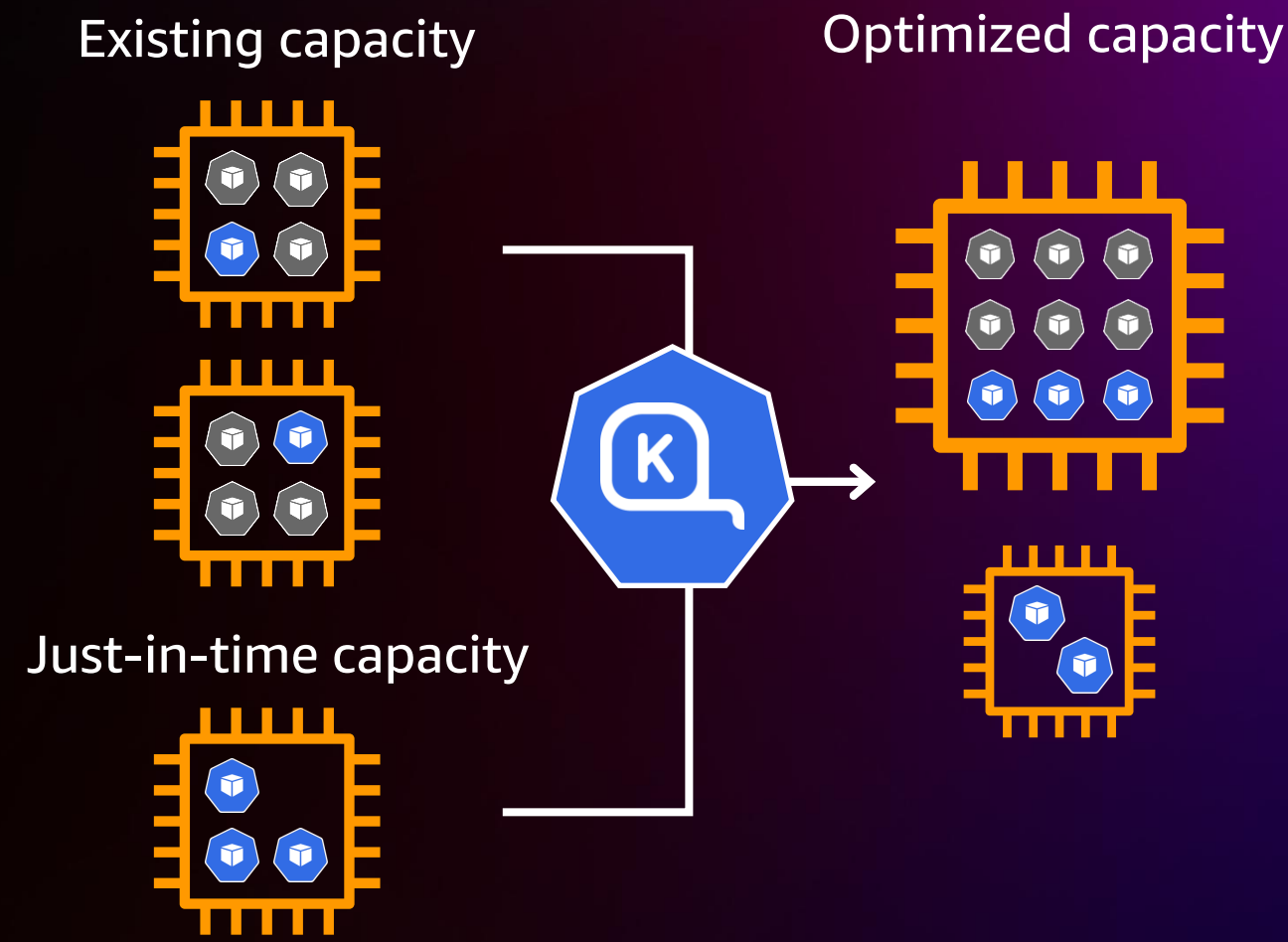
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Karpenter Consolidation

AUTOMATICALLY OPTIMIZING KUBERNETES COMPUTE COSTS WITH KARPENTER

Karpenter's **consolidation feature** improves cluster efficiency over time by

- Rescheduling running pods onto existing, under-utilized cluster capacity
- Launching new, more cost-efficient cluster capacity to replace nodes that have become under-utilized



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How Karpenter's consolidation feature works

AUTOMATICALLY OPTIMIZING KUBERNETES COMPUTE COSTS WITH KARPENTER

1. Wait for consolidation poll period
2. Identify candidate nodes
    a. Launched by a Provisioner with consolidation enabled
    b. No `do-not-consolidate` annotation
    c. Initialized, reports ready, all extended resources are registered
3. Sort nodes by disruption cost
4. Simulate scheduling without node with lowest disruption cost

---

Pod(s) can be scheduled on existing nodes → **Remove node**

Pod(s) can be scheduled on a cheaper node → **Shrink node**

Pod(s) require an equal or more expensive node → **Do nothing**

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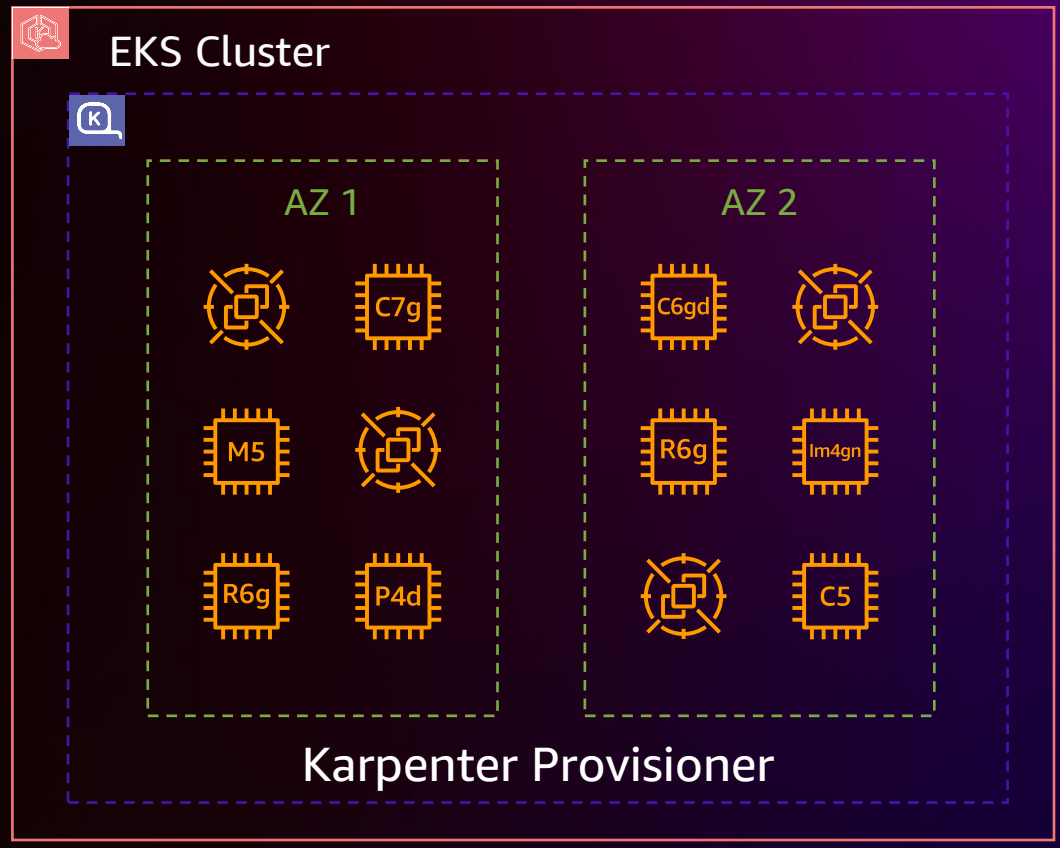
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Lowering costs with Amazon EKS and Karpenter

AUTOMATICALLY OPTIMIZING KUBERNETES COMPUTE COSTS WITH KARPENTER

Karpenter simplifies incorporating **AWS Graviton** and **EC2 Spot** to improve cluster utilization and lower costs

```
kind: Provisioner
spec:
 consolidation:
  enabled: true
 requirements:
  - key: karpenter.sh/capacity-type
    operator: In
    values: [“spot”, “on-demand”]
  - key: kubernetes.io/arch
    operator: In
    values: [“amd64”, “arm64”]
```

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Expedia Group uses Amazon EKS and Karpenter

AUTOMATICALLY OPTIMIZING KUBERNETES COMPUTE COSTS WITH KARPENTER

Expedia Group is **migrating approx. ten thousand applications** from a complex and diverse set of legacy environments onto **hundreds of EKS clusters with Karpenter**

- Expedia Group uses Karpenter to increase EC2 Spot diversity, lowering interruption rates and compute costs
- Karpenter greatly reduces operational overhead of EC2 Spot best practices at scale



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Wrapping up

OPTIMIZING AMAZON EKS FOR PERFORMANCE AND COST

Key takeaways

Inform

Amazon EKS with Kubecost provides granular cost allocation data

Optimize

Using Karpenter with Amazon EKS greatly simplifies introducing cost optimizing compute options like AWS Graviton and EC2 Spot

Operate

Never stop looking for new ways to improve utilization and lower costs

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Thank you!

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Raghav Tripathi
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