Docker on AWS - the Right Way

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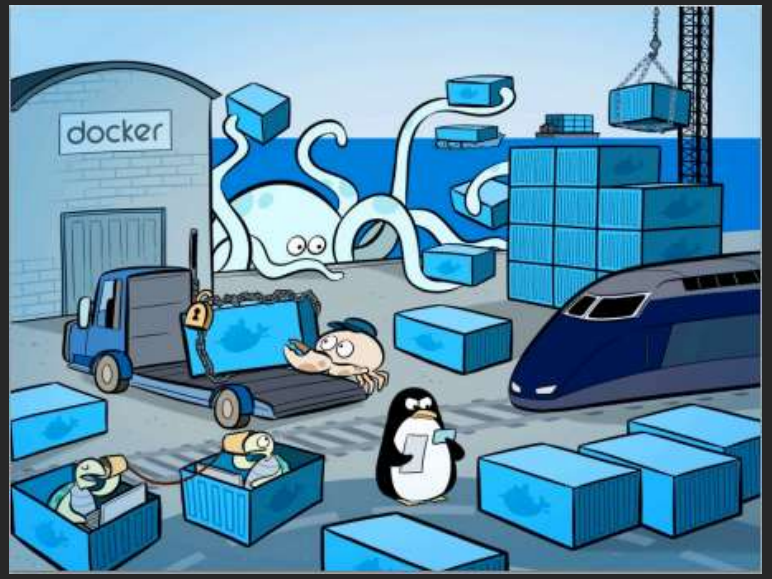
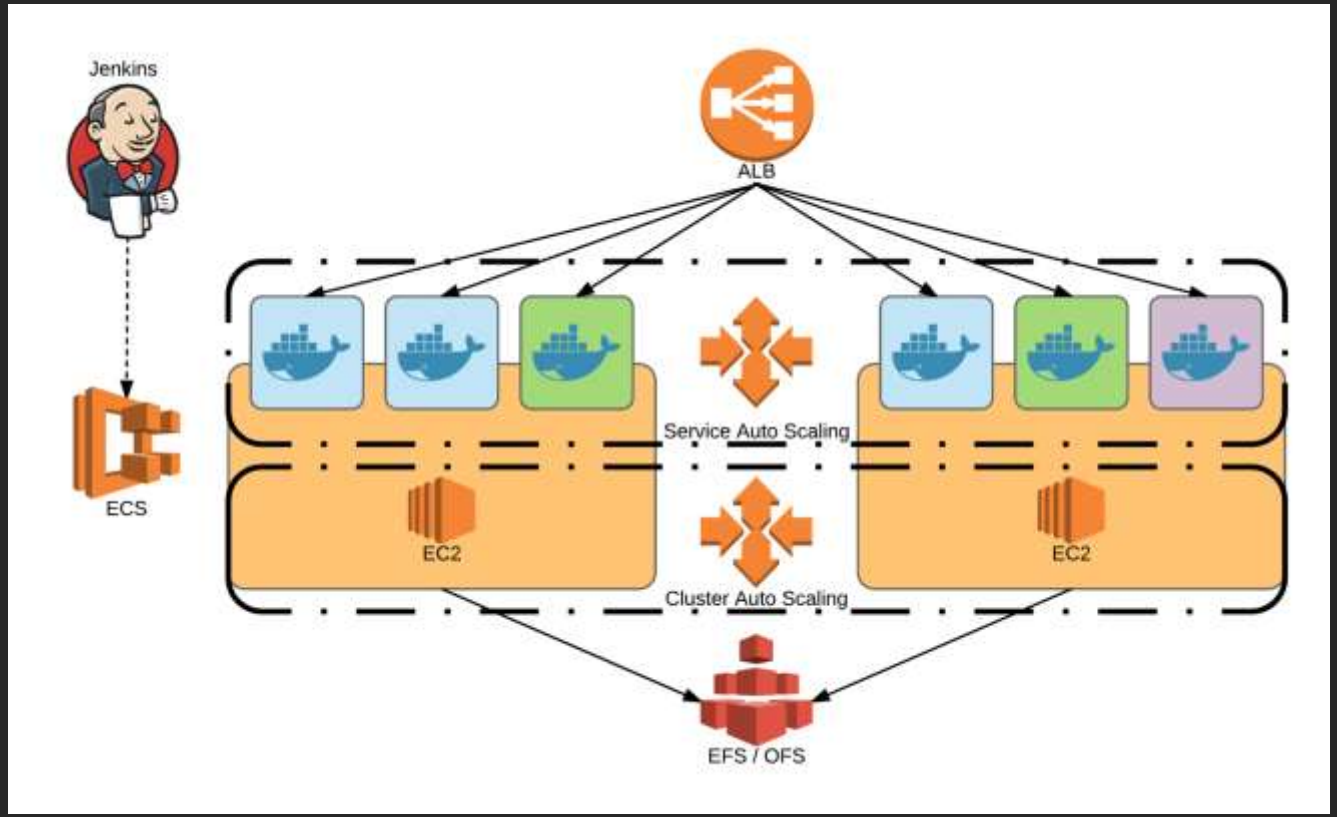
Johanan Lieberman

Agenda

- Container Orchestration on AWS
- Service Discovery
- Service Load Balancing
- Auto Scaling
- Storage
- Continuous Integration & Delivery



Reference Architecture



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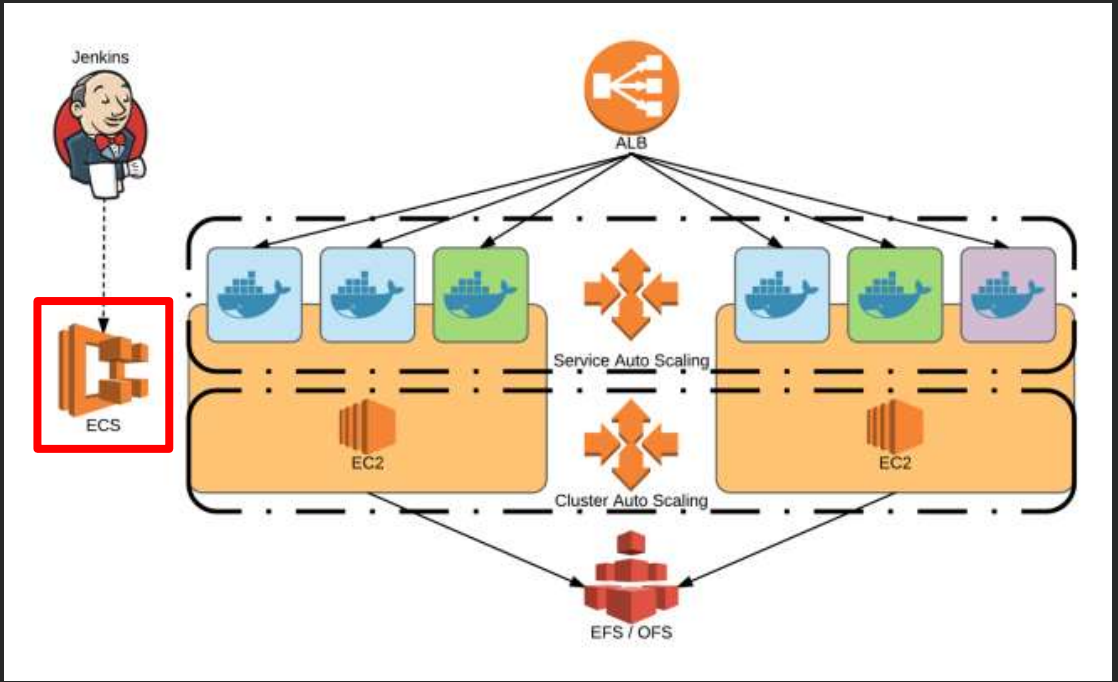
Container Orchestration on AWS



What is Container Orchestration?

- Technologies which allow us to:
  - Create multi-node container clusters
  - Manage multiple containers easily
  - Automate container lifecycle

Why Do We Need Container Orchestration?

- Horizontal scalability across multiple hosts
- Grouping of related containers
- Automatic failure detection and recovery
- Seamless updates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ECS - EC2 Container Service

- Docker container orchestration service by AWS
- Operates on top of EC2
- Built-in private Docker registry (ECR)

Why Use ECS?

- Built-in security
  - Assign IAM Roles to Docker containers
  - Docker registry authentication using IAM
- Native integration with ELB and Auto Scaling
- Spot fleet + Auto Scaling support (announced Sep. 1, 2016)
- Full support from AWS

ECS Components

- **Cluster** - a group of container instances
- **Container Instance** - an EC2 instance that hosts containers
- **Task** - a set of related Docker containers
- **Task Definition** - a template which defines a task
- **Service** - a group of identical tasks

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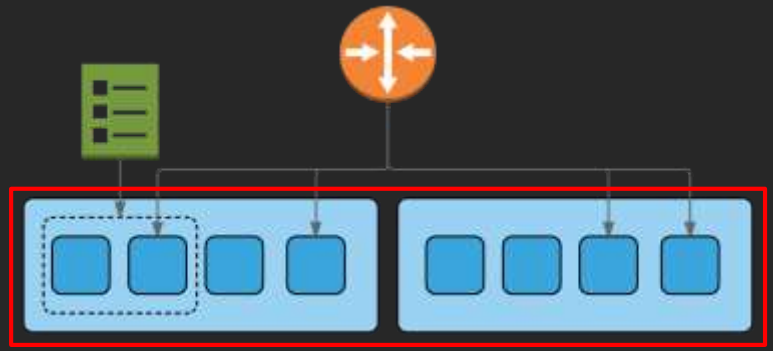
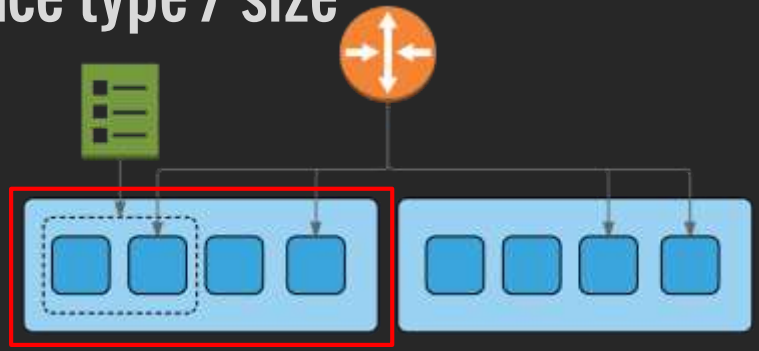
Cluster

- A group of container instances
- Supports multiple Availability Zones
- Bound to a specific AWS region



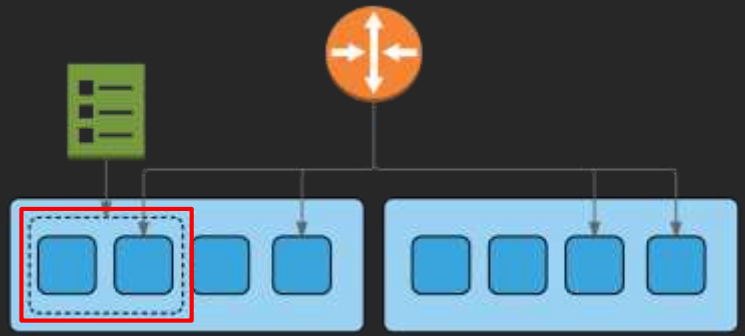
Container Instance

- An EC2 instance running Docker with an ECS agent
- May be deployed from an official AWS AMI
- May be deployed using an Auto Scaling group
- Can be of any EC2 instance type / size



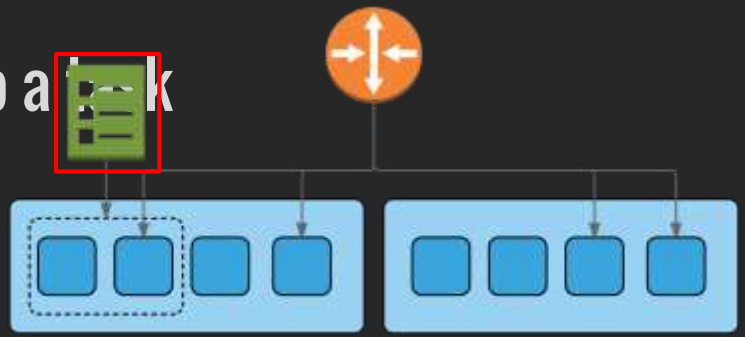
Task

- A set of one or more related containers
- Deployed to a cluster
- Containers within a task are placed on the same host



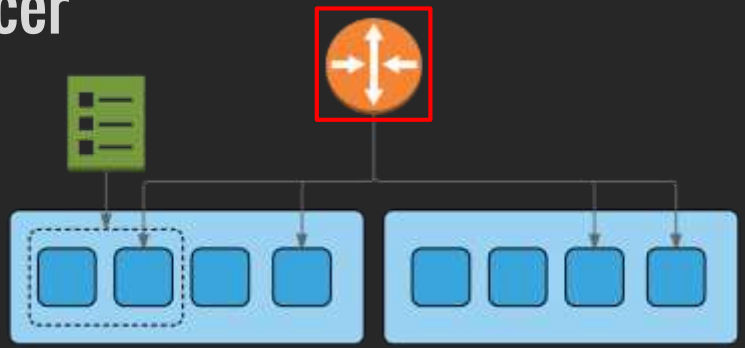
Task Definition

- Serves as a “template” for tasks
- Allows to define most of the Docker features accessible via docker run (image, volumes, networking, env vars...)
- Allows to define CPU and memory limits for the tasks
- Can assign an IAM role to a task
- Configurable using JSON



Service

- An abstraction above tasks
- Deploys multiple “copies” from a task definition
- Maintaines the desired number of running tasks
- May bind to a load balancer



ECS Components

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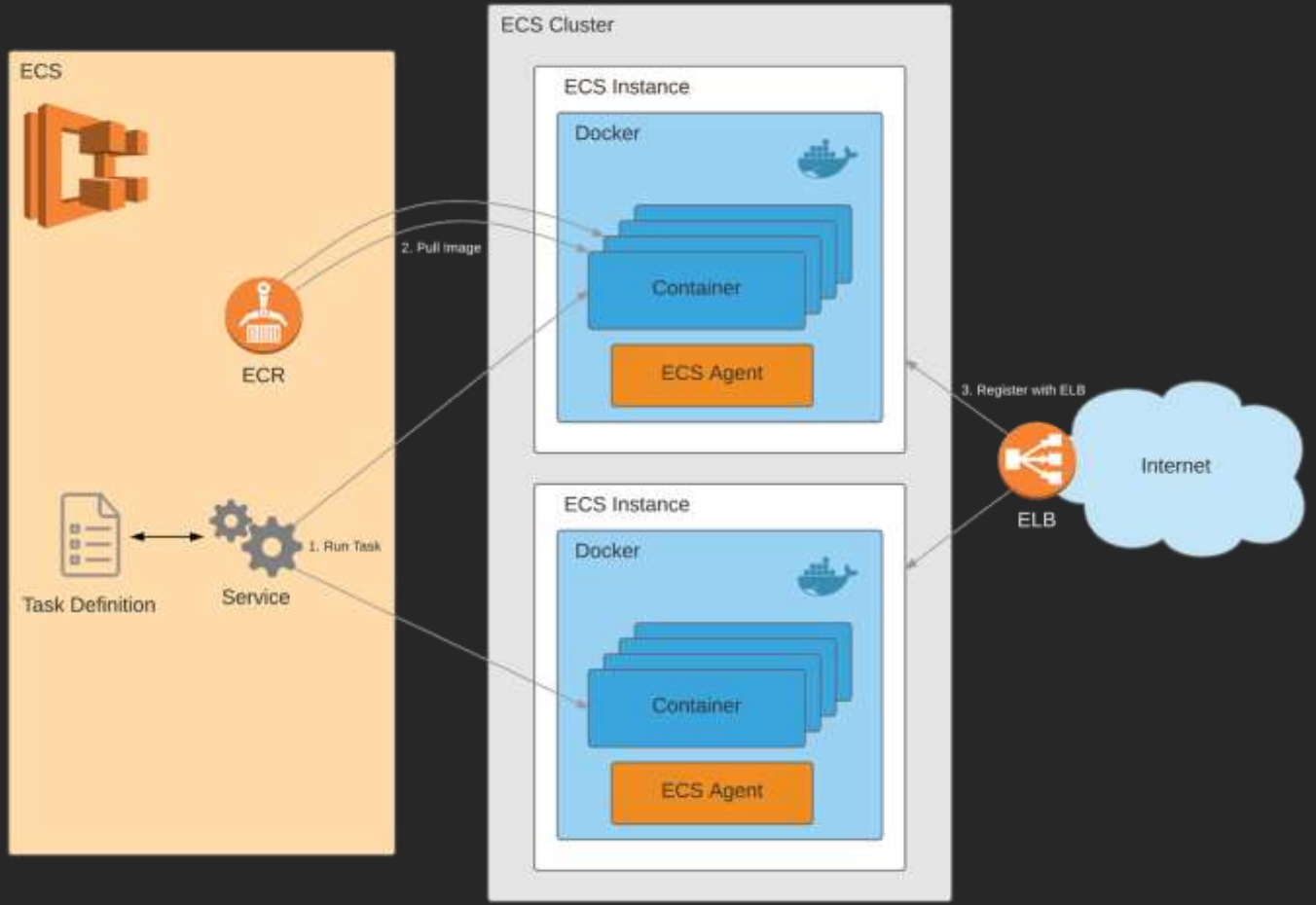
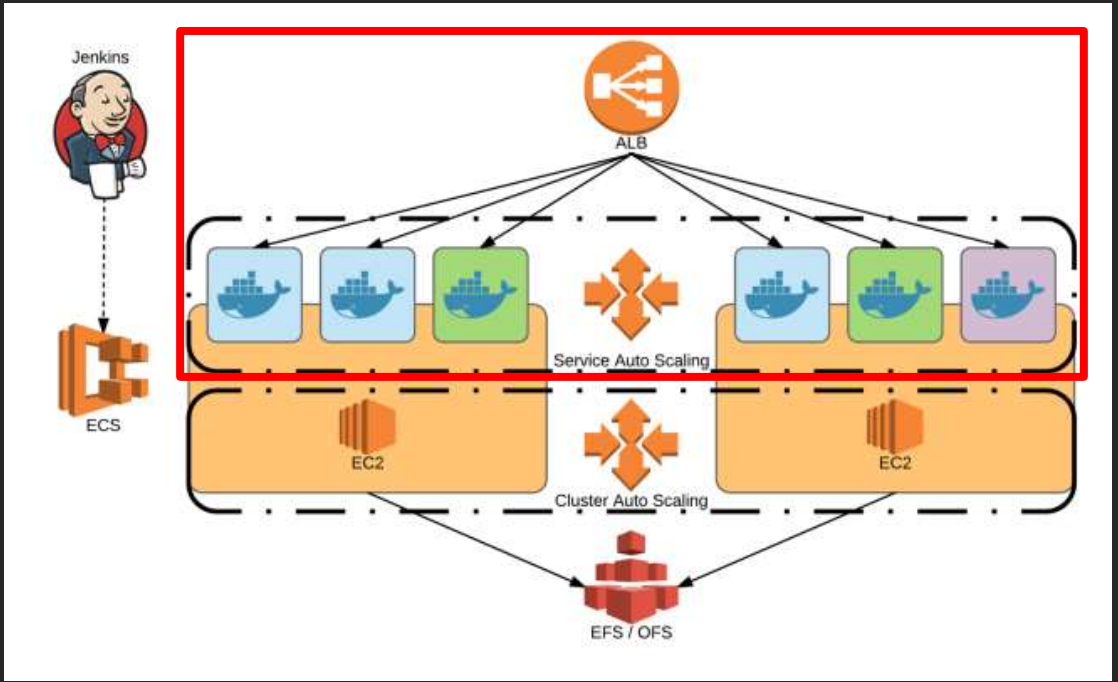


ECS - Summary & Best Practices

- Use ECS to easily manage containerized apps on AWS
- Deploy ECS instances in multiple AZs for high availability
- Choose an instance type that is appropriate for your apps

Service Discovery



Question:

How does a client know where to send a request when a service runs on multiple nodes?

What is Service Discovery?

- A mechanism which allows a client to find out the network location of a service automatically

Why Do We Need Service Discovery?

- Cloud environments change all the time
- IP addresses and ports are assigned dynamically
- Auto Scaling launches and terminates instances
- Some instances might be under maintenance or upgrade

Understanding the Problem

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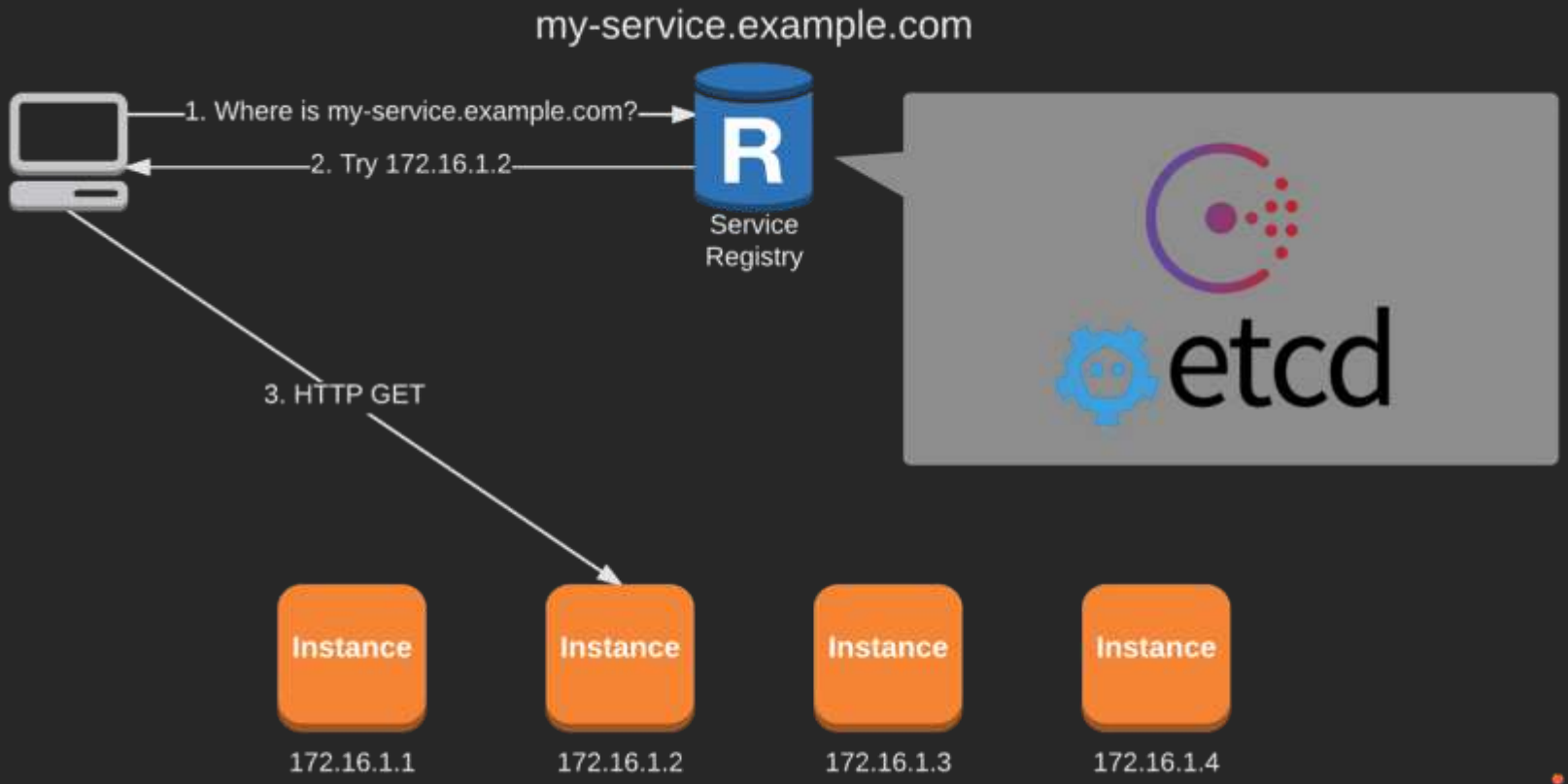
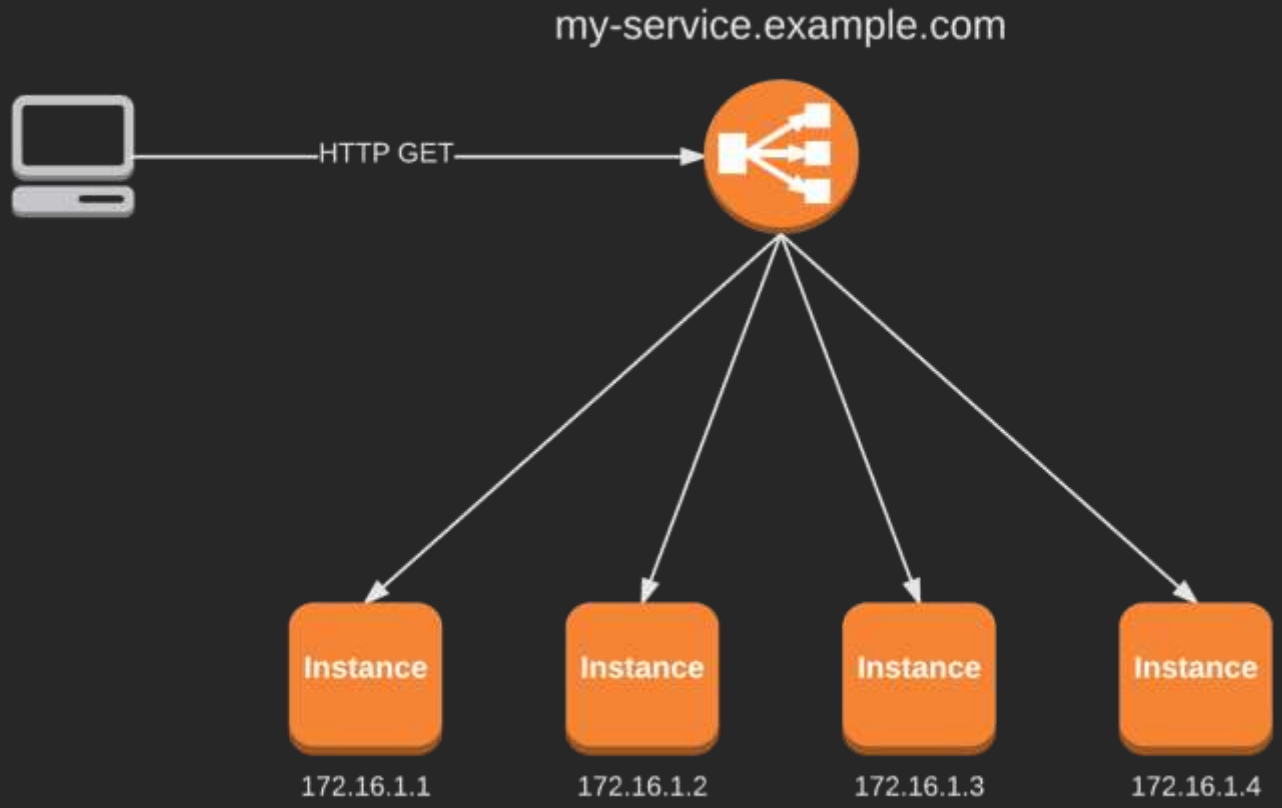
Service Discovery Using a Service Registry



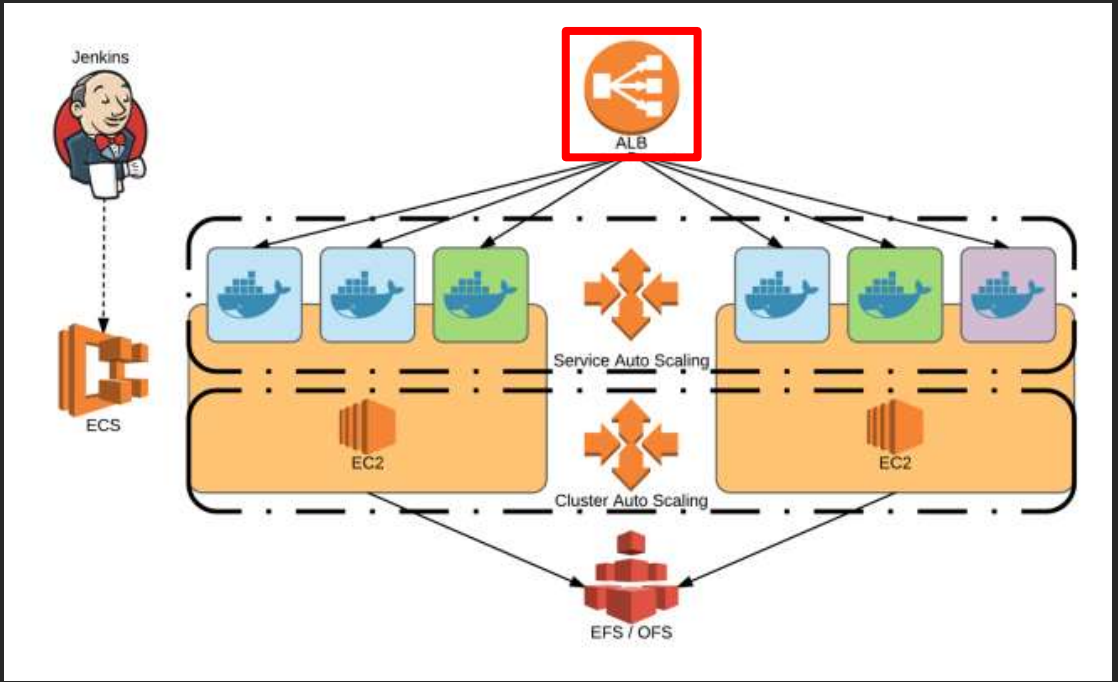
Service Discovery Using a Load Balancer



Service Discovery - Summary & Best Practices

- Cloud environments are dynamic and require service discovery
- There are multiple solutions for service discovery
- Use load balancers when possible
- Architectures combining a service registry and load balancers are possible but are more complicated

Service Load Balancing



Question:

How can we provide a single point of access to a service which runs on multiple containers?

What is Service Load Balancing?

- A mechanism which provides a single point of access to an ECS service
- Routes traffic to multiple containers
- Can be internet-facing or internal
- Powered by AWS ELB
- Complements Auto Scaling

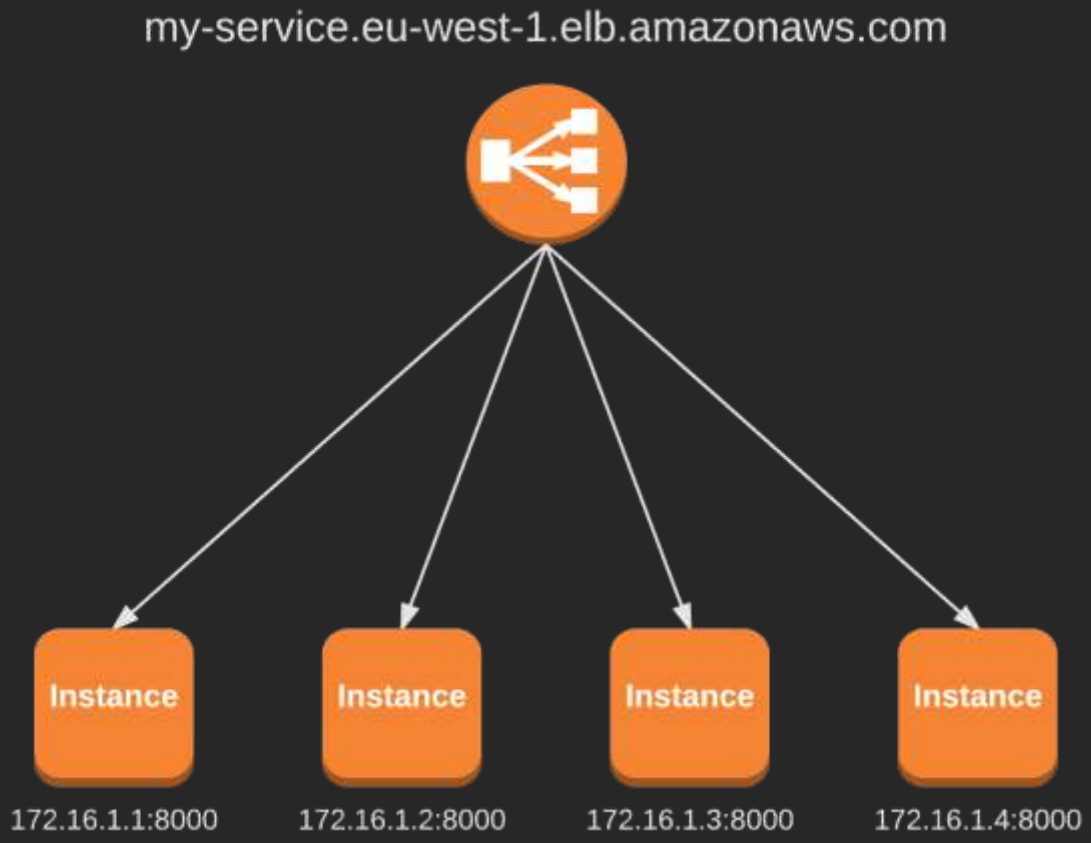
Why Use Service Load Balancing?

- Native integration with ECS
- Highly-available and auto-scaling by design
- Provides session stickiness
- Built-in health checks per service
- Support for VPC Security Groups

ELB - Classic Load Balancer

- A mature AWS service
- Routes traffic among EC2 instances
- Supports Layer 4 routing or (limited) Layer 7 routing
- No support for dynamic ports

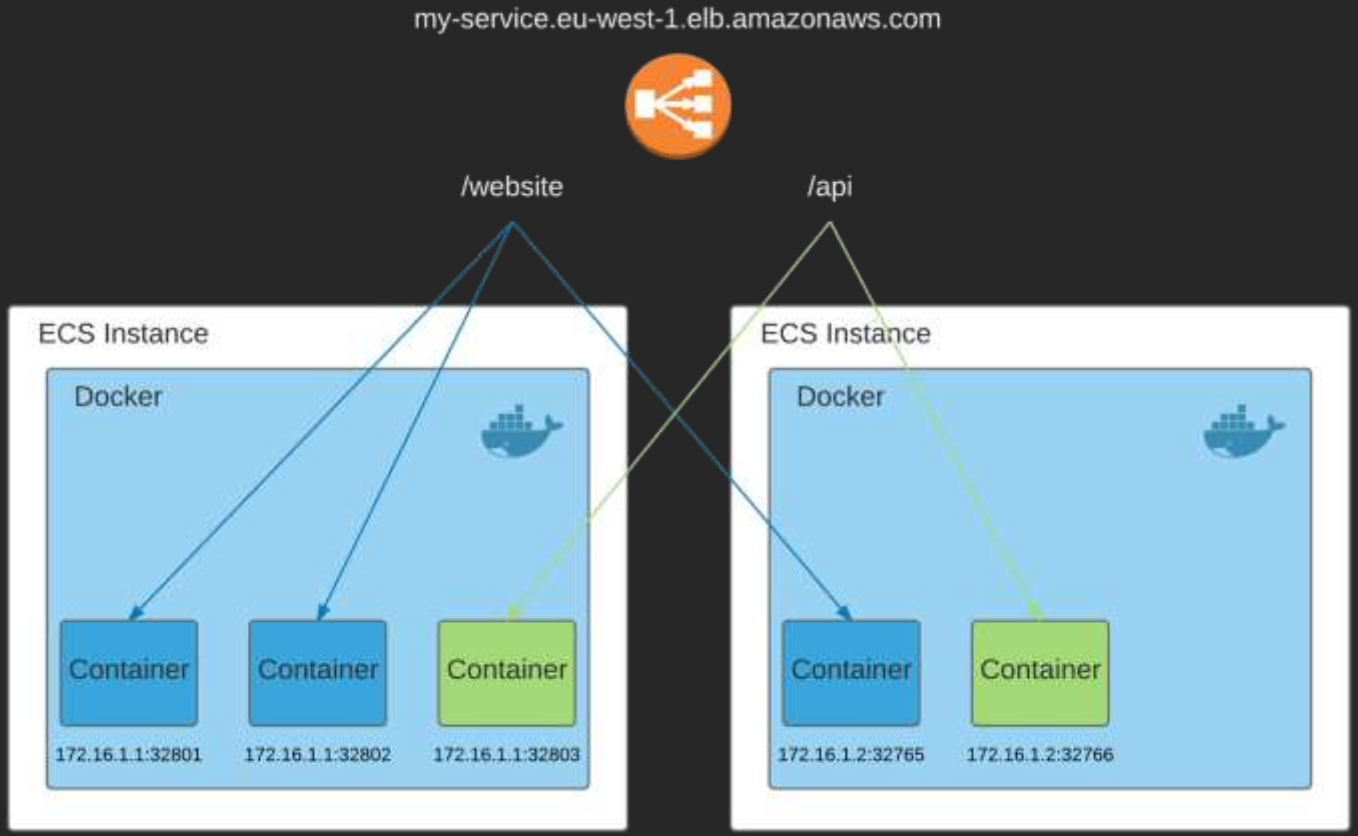
ELB - Classic Load Balancer



ELB - Application Load Balancer

- A new AWS service (announced Aug. 11, 2016)
- Supports containerized applications
- Routes traffic among EC2 instances or ECS tasks
- Supports Layer 4 routing or HTTP path-based routing
- Supports per-service health checks
- Cheaper than the classic ELB

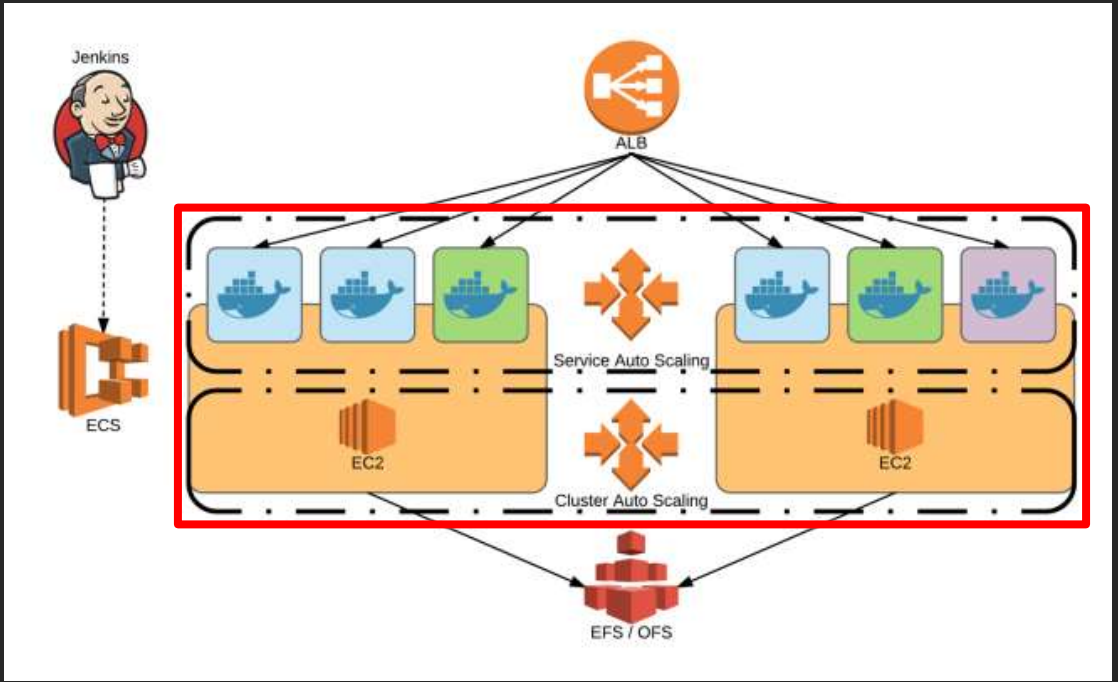
ELB - Application Load Balancer



Service Load Balancing - Summary & Best Practices

- Two types of load balancers - ELB and ALB
- Use ALBs whenever possible
- Save costs by using path-based routing - one ALB can serve a big cluster with multiple services

Auto Scaling



Question:

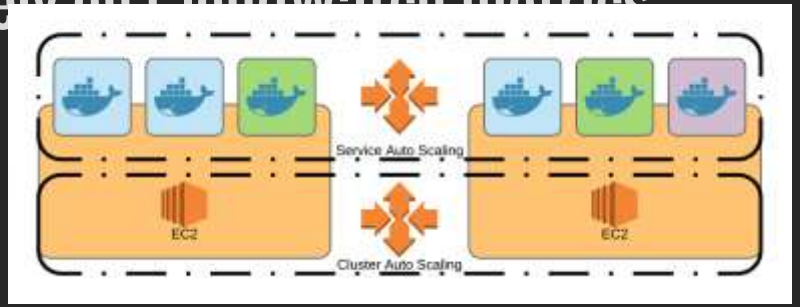
How can we automatically scale an ECS service based on load?

What is Auto Scaling?

- Automatically adjusting the capacity of the application's infrastructure based on load

Auto Scaling in ECS

- Service Auto Scaling - adjusting the number of running ECS tasks for the given service
- Cluster Auto Scaling - adjusting the number of EC2 instances in the cluster
- Both types rely on CloudWatch metrics



ECS Resource Allocation

- Each container gets a portion of the CPU and memory of the host on which it runs
- This capacity is reserved for each container
- The remaining capacity is shared among all containers
- Resource allocation is configured in the task definition

CPU Resource Allocation

- Each ECS instance has 1024 CPU units per CPU core
- A container gets a relative amount of CPU cycles based on the configured units
- The configured units are reserved for the container
- CPU allocation is only relevant when there is competition on host resources
- The remaining CPU capacity may be used by other containers

Memory Resource Allocation

- Soft limit - the amount is reserved for the container but may be exceeded if capacity is available
- Hard limit - container is killed when trying to exceed the reserved amount
- Must use one limit type but may use both together

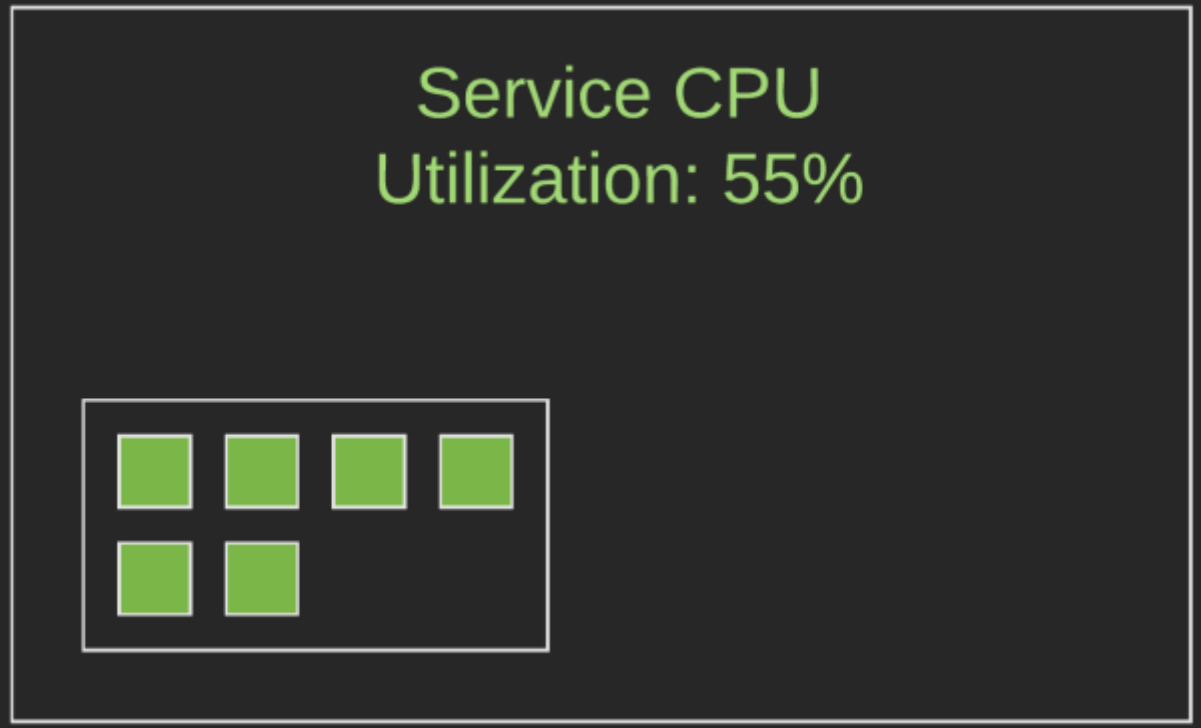
Service Auto Scaling

- Adding more containers to handle an increasing load
- Configured inside ECS
- Use CPU and memory usage to trigger scaling events
- May use custom CloudWatch metrics too
- “Do we have enough compute power?”

Cluster Auto Scaling

- Adding more instances to accommodate an increasing number of containers
- Configured via EC2 Auto Scaling
- Use CPU and memory reservation to trigger scaling events
- “Do we have room for more containers?”

Auto Scaling in Action



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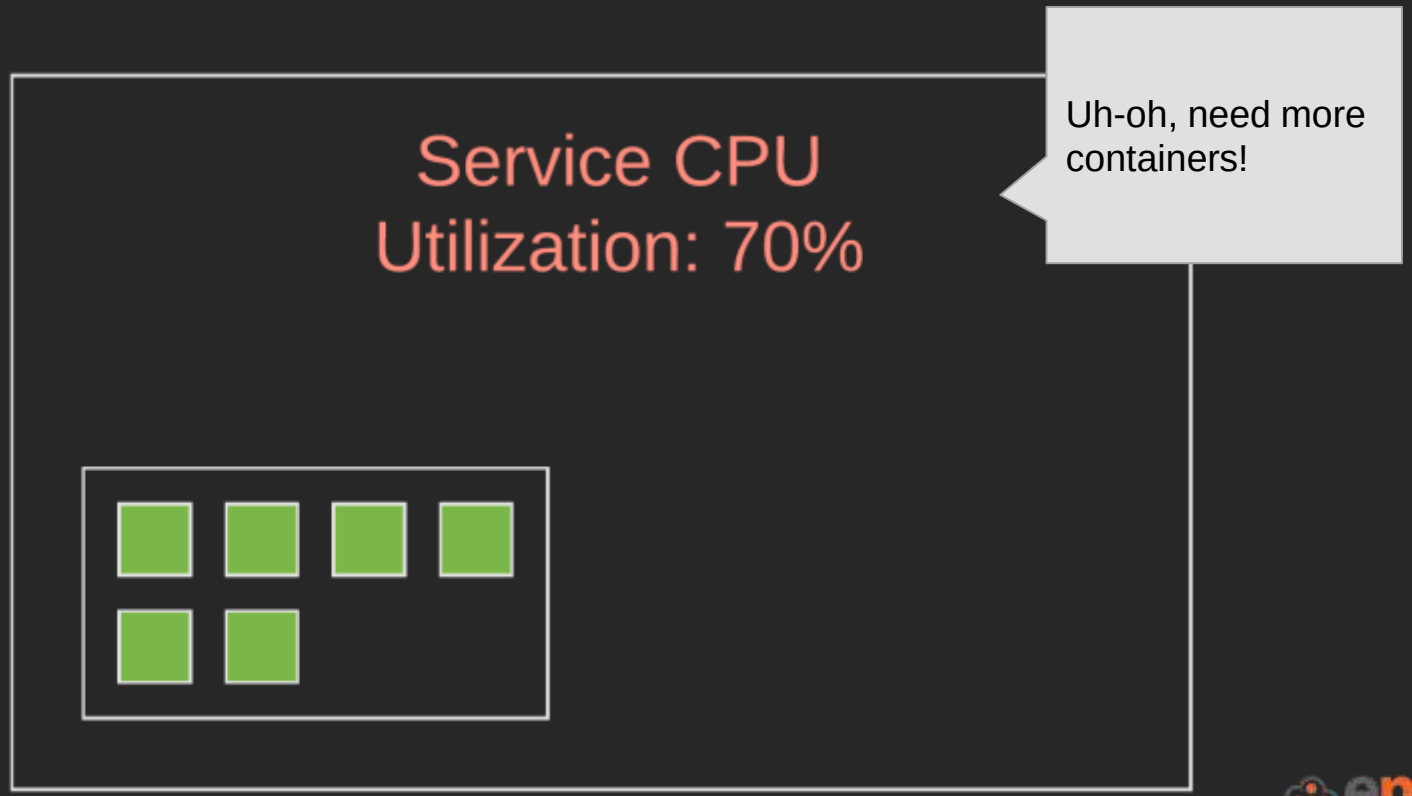

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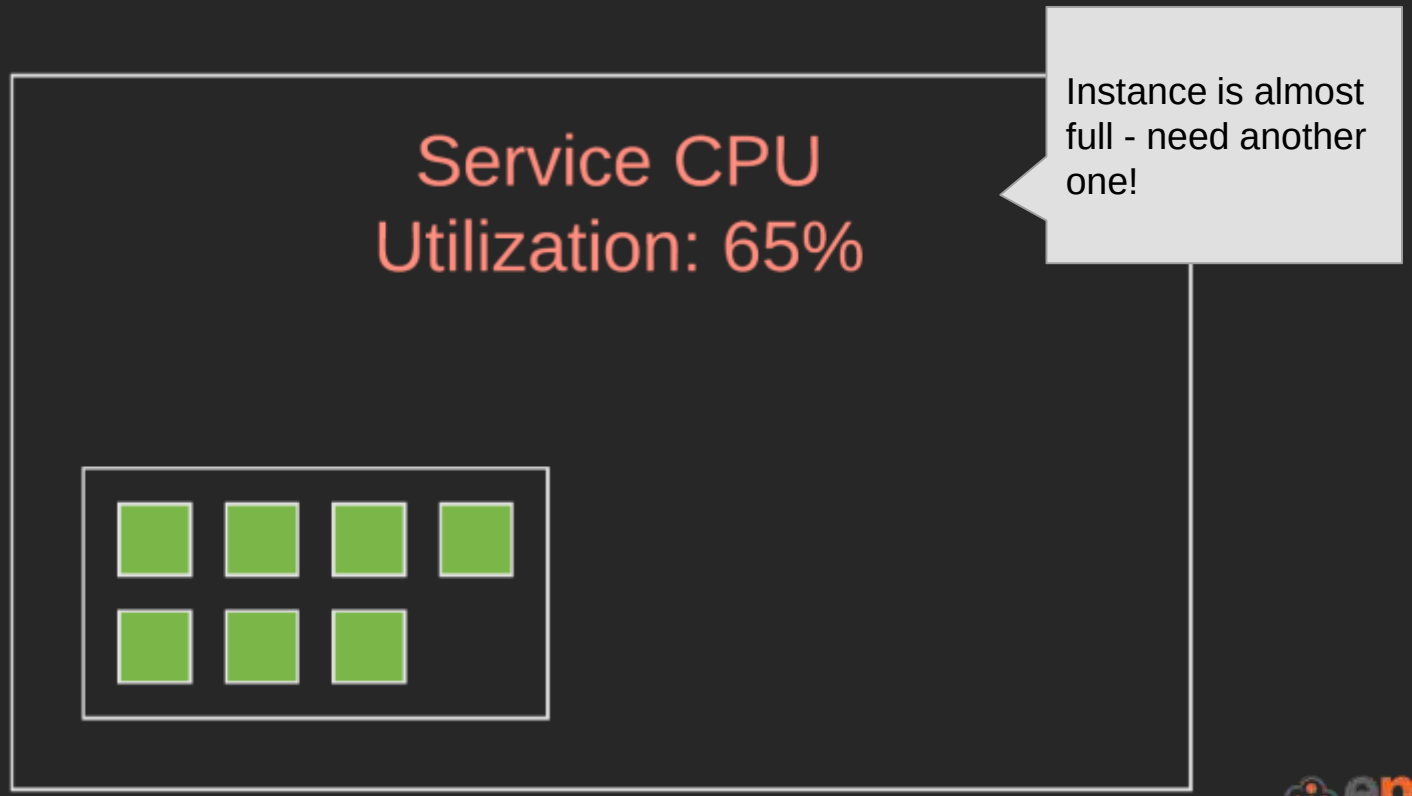

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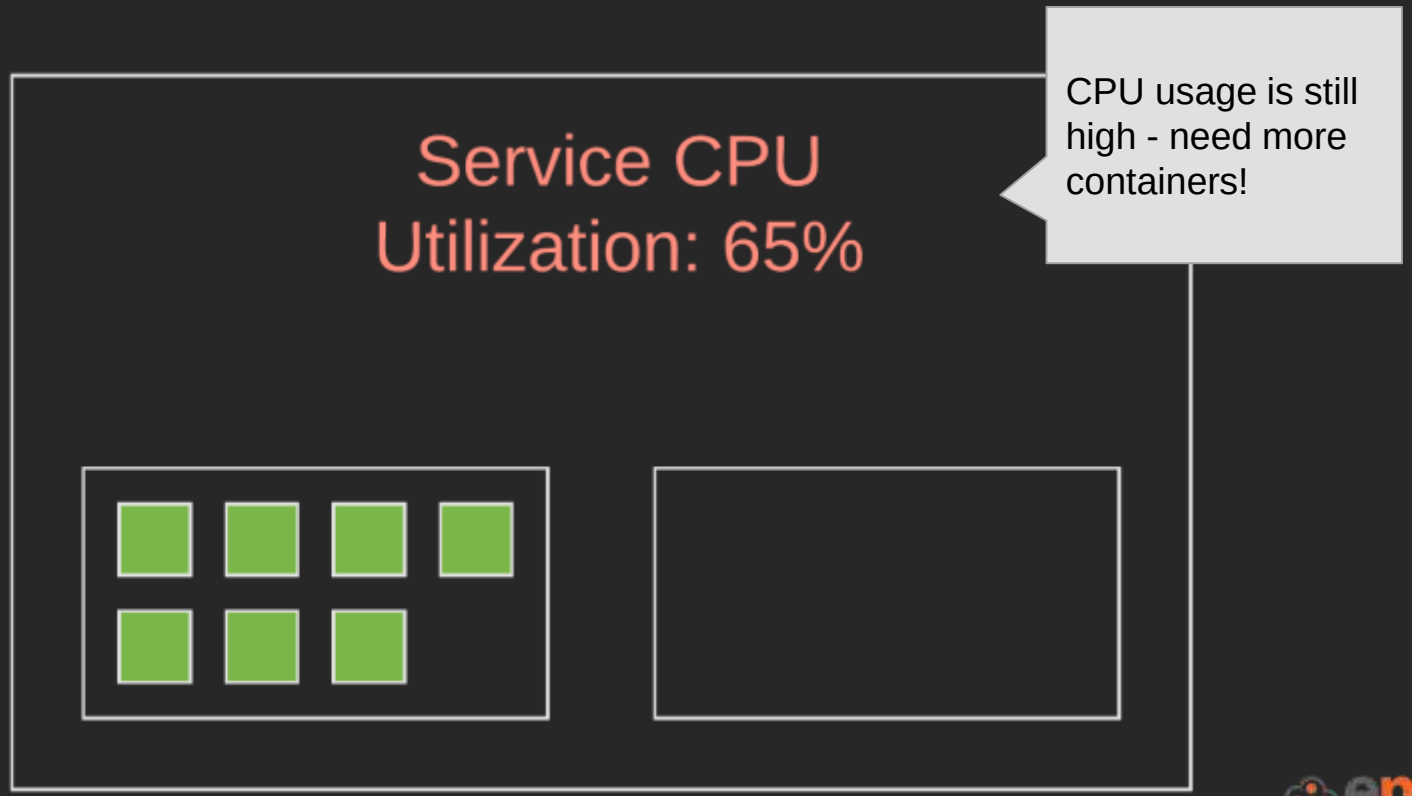

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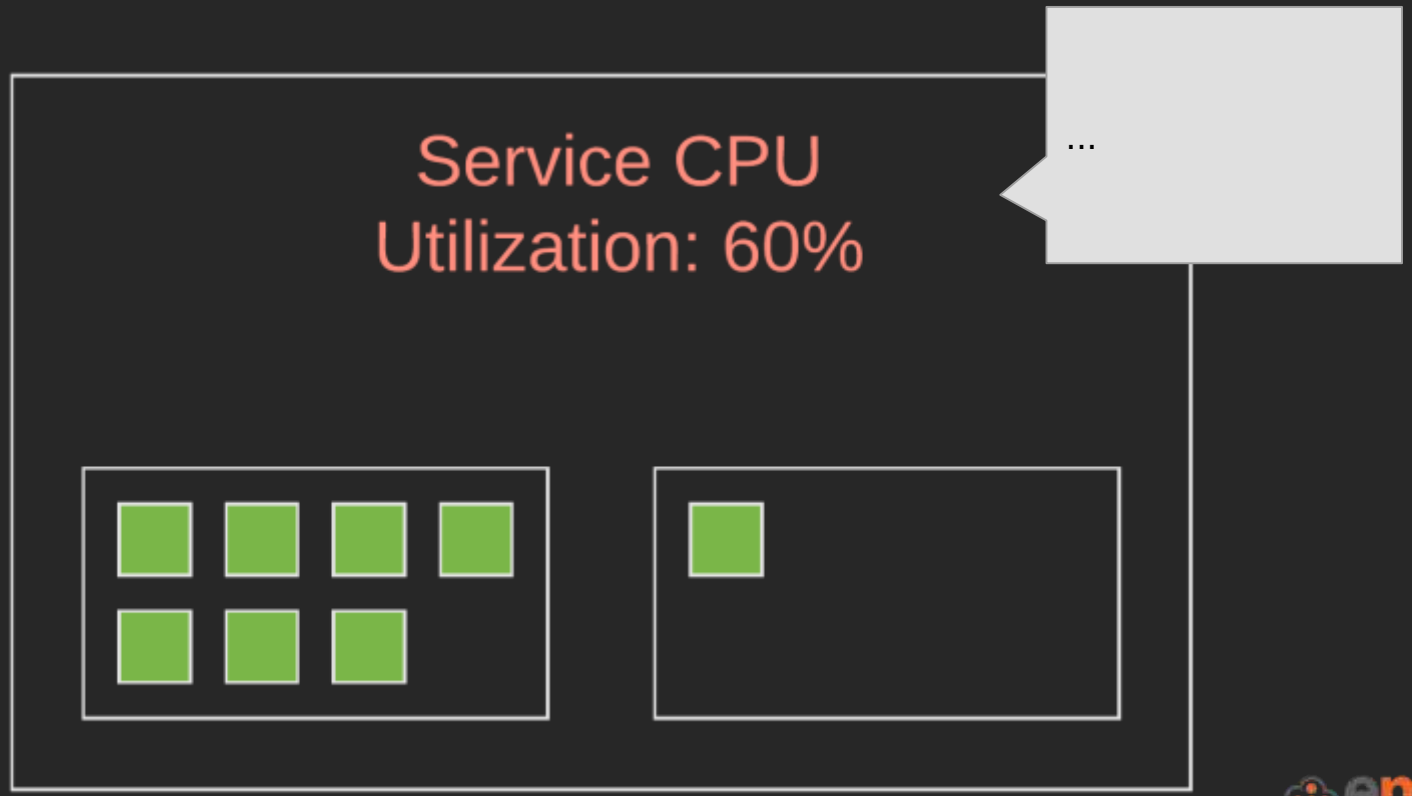
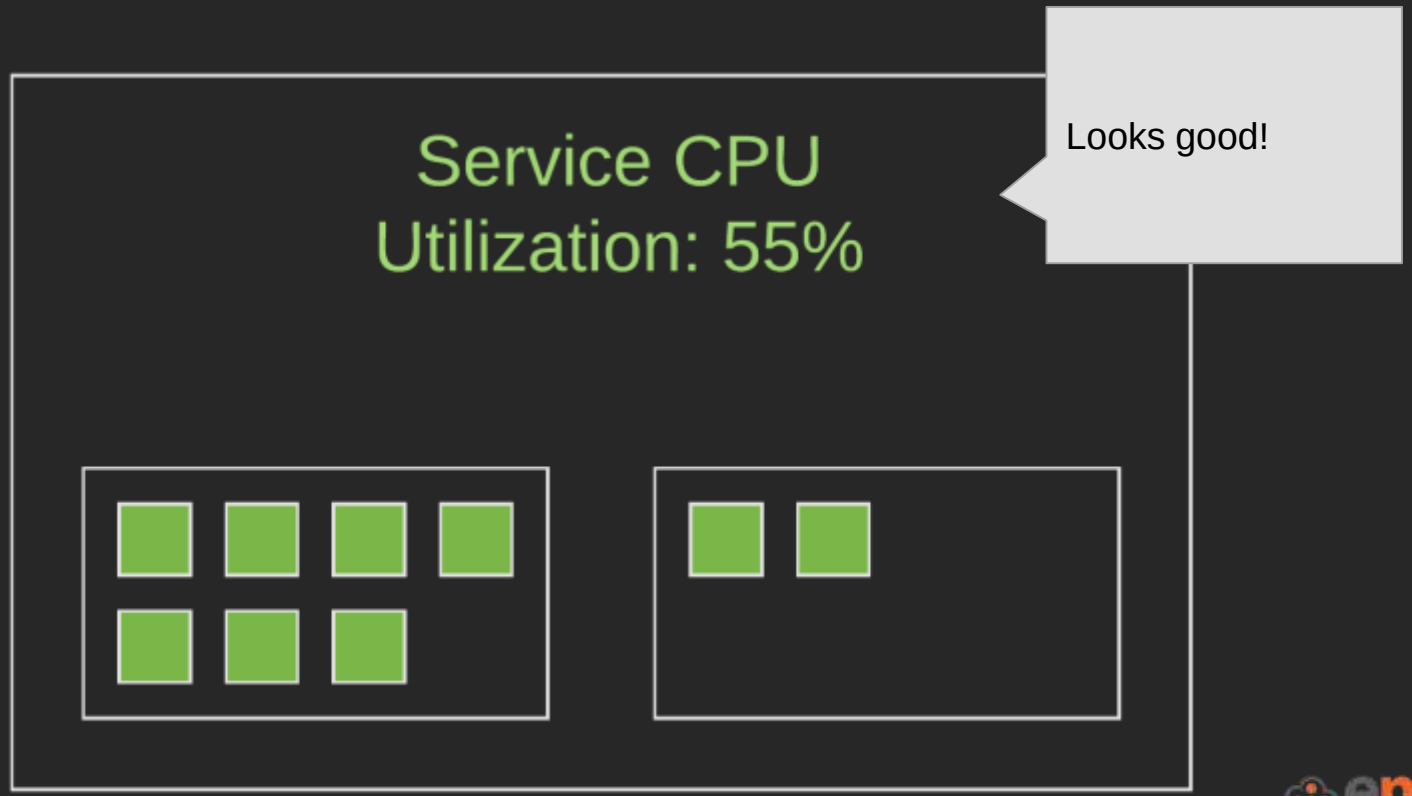


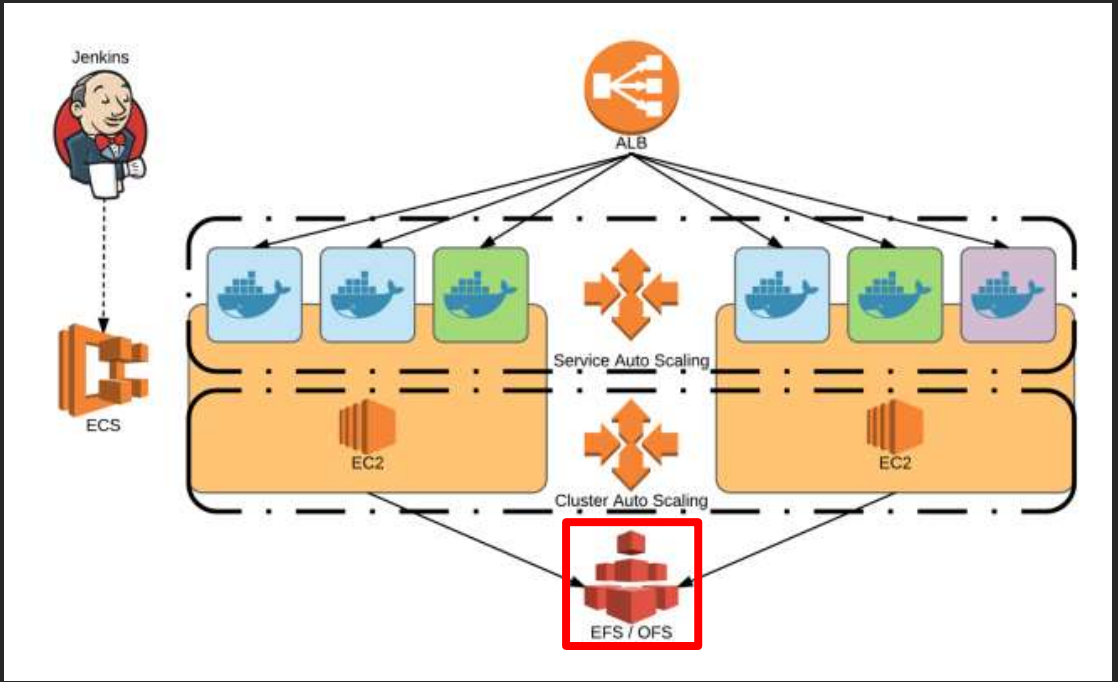
Auto Scaling in Action



Auto Scaling - Summary & Best Practices

- Configure both Service Auto Scaling and Cluster Auto Scaling
- Scale services based on utilization
- Scale clusters based on reservation
- Service Auto Scaling is much faster than Cluster Auto Scaling
- Leave some spare capacity on each host
  - Allows the cluster to scale in time

Storage



Question:

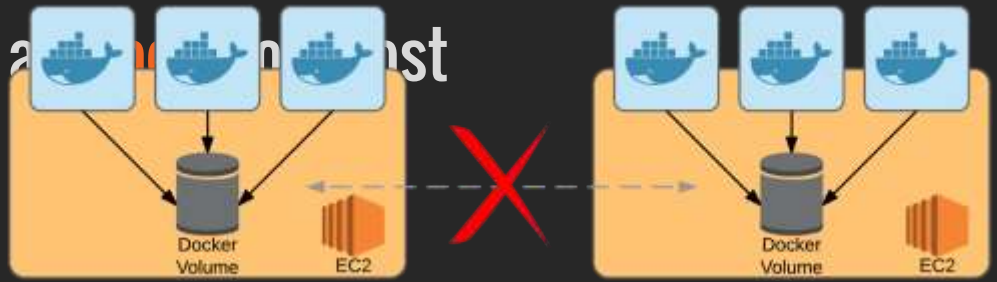
How to persist data used by a containerized application and share it among containers on multiple hosts?

Storage in Docker

- Docker containers are volatile
- Docker uses Union File Systems for container storage
- Data that is written to the Union File System doesn't persist

Docker Volumes

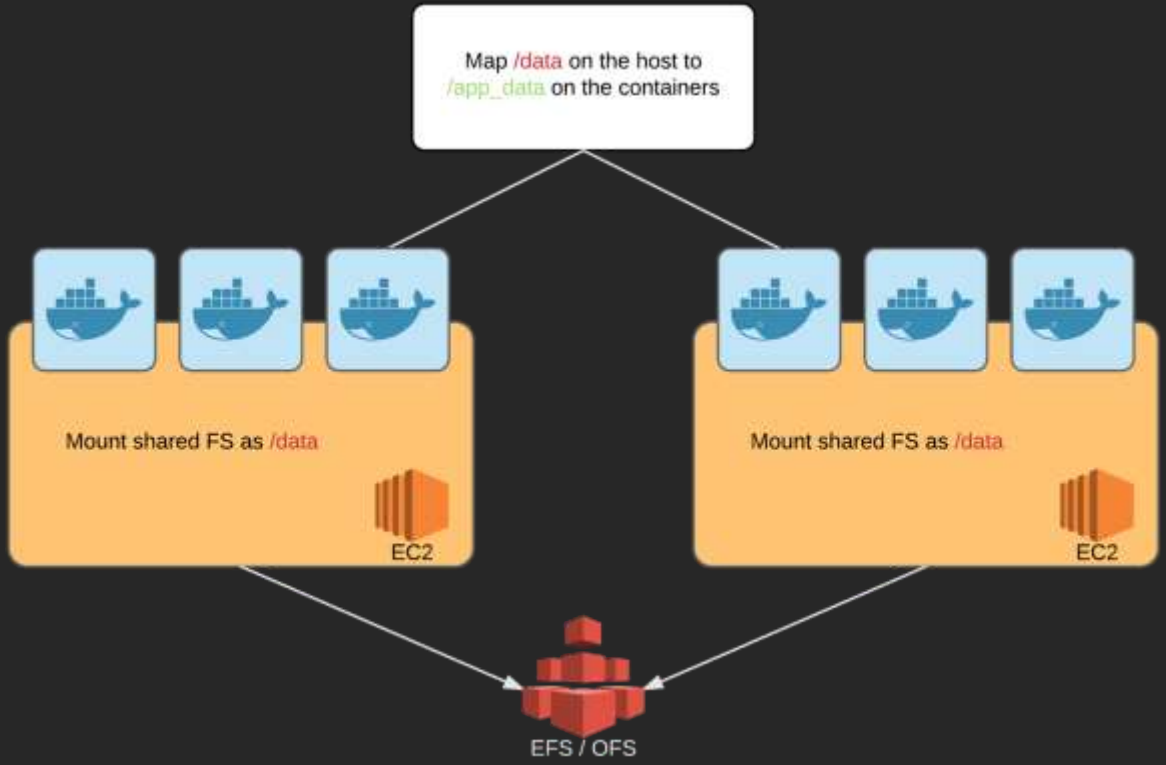
- Docker volumes can be used to persist data and share data between containers
- Docker volumes bypass the Union File System
- Host directories may be mounted as volumes
- Volumes a[illegible]st



Shared File Systems

- Elastic File System (EFS) - a shared storage solution by AWS
- ObjectiveFS - a 3rd party shared storage solution on top of S3
- Both solutions provide the following:
  - A shared file system which can be accessed by multiple servers at the same time
  - Unlimited capacity which expands automatically
  - High availability by design

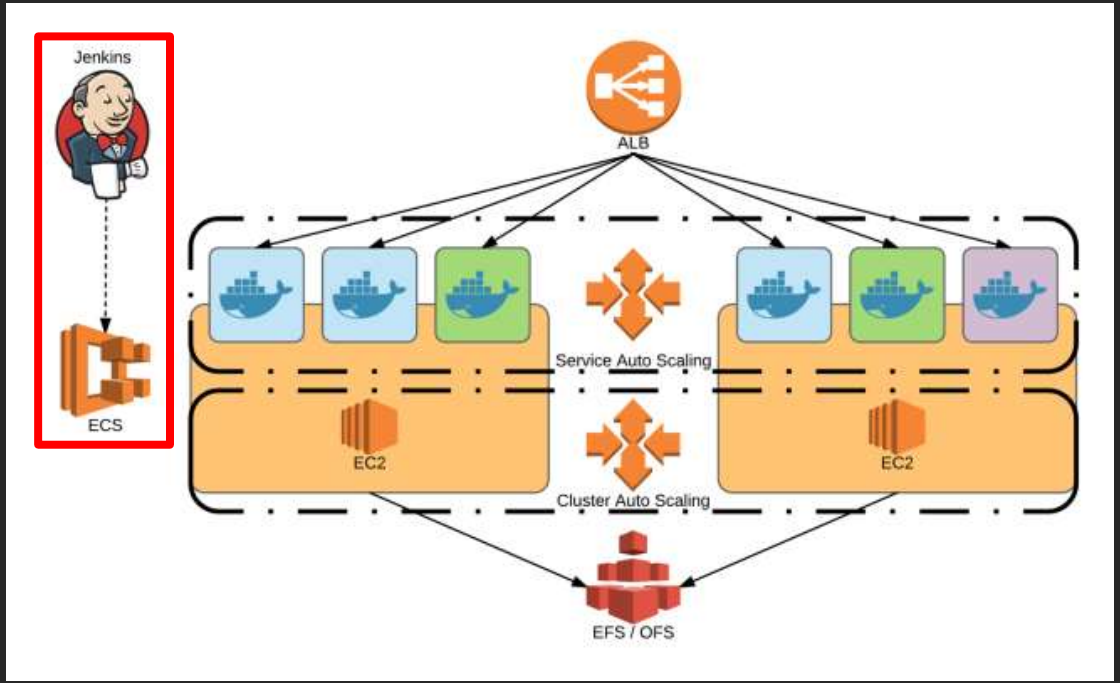
Using a Shared File System



Storage - Summary & Best Practices

- Use Docker volumes for persistence and for sharing data between containers
- Mount a shared file system on each host and map Docker volumes to it

Continuous Integration & Delivery



Question:

How to deploy applications to ECS and update them without service disruption?

CI/CD with ECS

- ECS can use Docker images from ECR or any other registry
- You can specify which images to deploy using task definitions
- ECS allows you to perform rolling updates to running services
- Updates can be triggered automatically using the ECS API
- Jenkins or any other CI/CD solution may be used to automate the process

CI/CD with ECS - Workflow

1. Checkout source from version control to Jenkins server
2. Build a new Docker image
3. Push the new image to ECR
4. Update the task definition & service
5. ECS updates the containers on the cluster

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Using Docker Tags

- Docker tags allow you to manage Docker images easily
- When building a new Docker image you must tag it
- Any string may be used as a tag
- The "latest" tag is used as a default tag if no tag is specified when building an image or running a container

The “latest” Tag is Dangerous!

- Using the “latest” tag in CI/CD may lead to problems
- Pushing an image with a tag that already exists in the repository will cause that tag to move to the new image
- This can lead to two containers which appear to use the same image but in fact have different code
- A good use for “latest” is to indicate a stable or default version on a public Docker repository

Tagging Strategy

- It is important to implement a proper tagging strategy when using Docker for CI/CD
- Common tag values:
  - Application version (“1.3”)
  - CI/CD build number (“136”)
  - Git SHA value (“ca82a6d”)
- Using one of the above will make sure your tags are unique

CI/CD - Summary & Best Practices

- Use Jenkins to build new Docker images and push them to ECR
- Use Jenkins to trigger rolling updates on ECS
- Implement a proper tagging strategy
- Use the “latest” carefully and in addition to a version tag

Thank You!

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