# Cloud Architectures

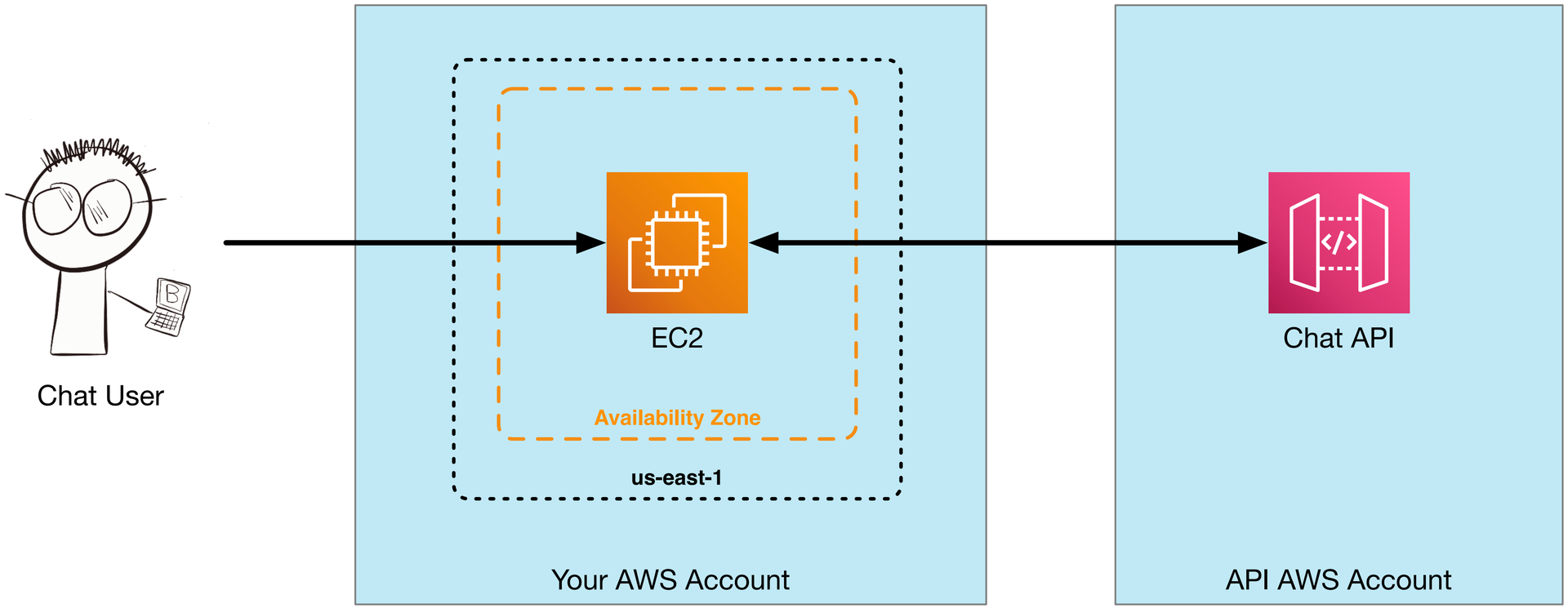
# Cloud Architectures

## Reading and Understanding Architecture Diagrams

- Architecture diagrams are a visual overview of the major pieces involved in an application
- Can be as sparse or detailed as you need
- Usually tailored to the audience
  - Developers want to see a more detailed diagram
  - Executives want to see a higher level diagram

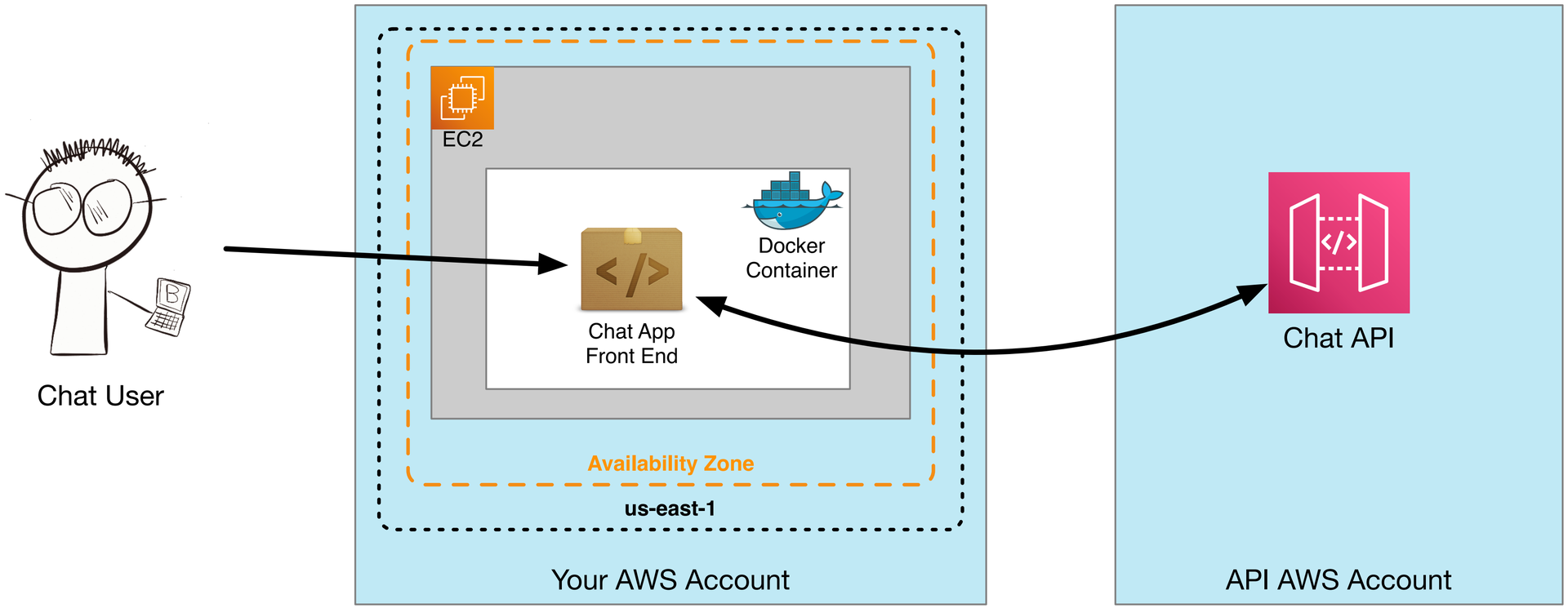
# Cloud Architectures

## High Level Chat App Diagram



# Cloud Architectures

## More Detailed Chat App Diagram



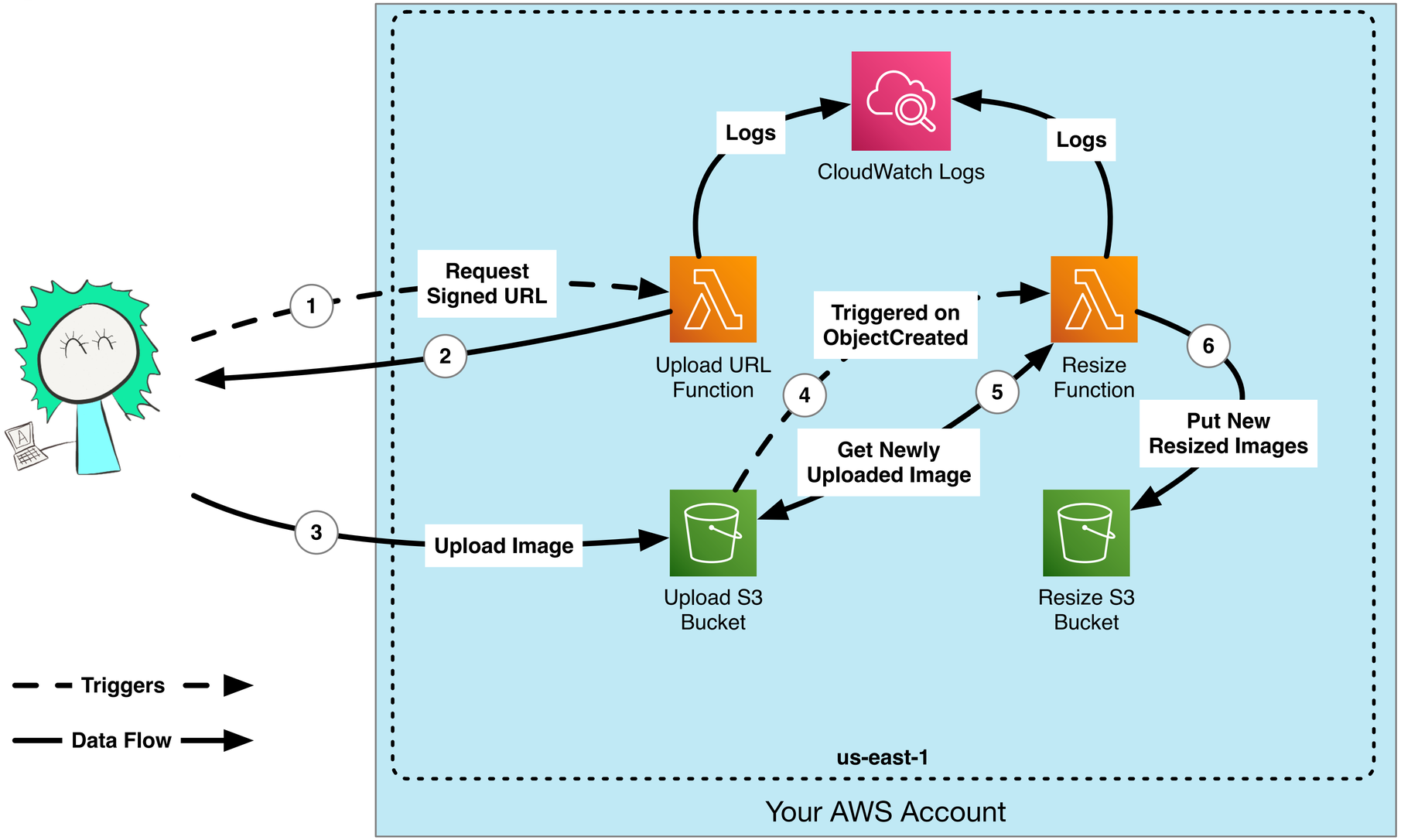
# Cloud Architectures

## Image Upload Lambda Functions

- How about a diagram for Homework 7?
- What were the pieces we had?
  - 2 S3 Buckets
  - 2 Lambda Functions
  - A user
  - An Image File
  - Resized Images

# Cloud Architectures

## Image Upload Lambda Functions



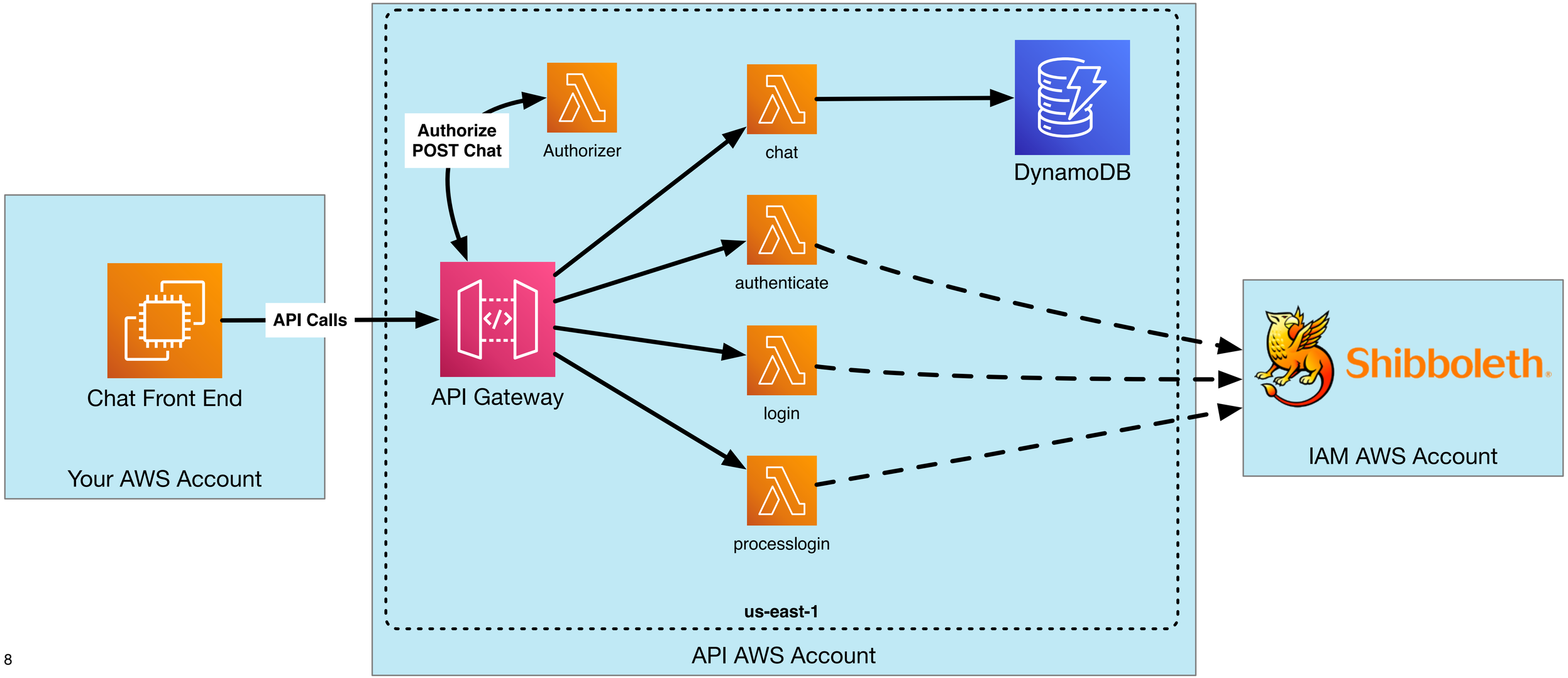
# Cloud Architectures

## Chat API Back End

- What does the Architecture Diagram look like for the Chat API back end?
- Major building blocks
  - API Gateway
  - Lambda
  - DynamoDB

# Cloud Architectures

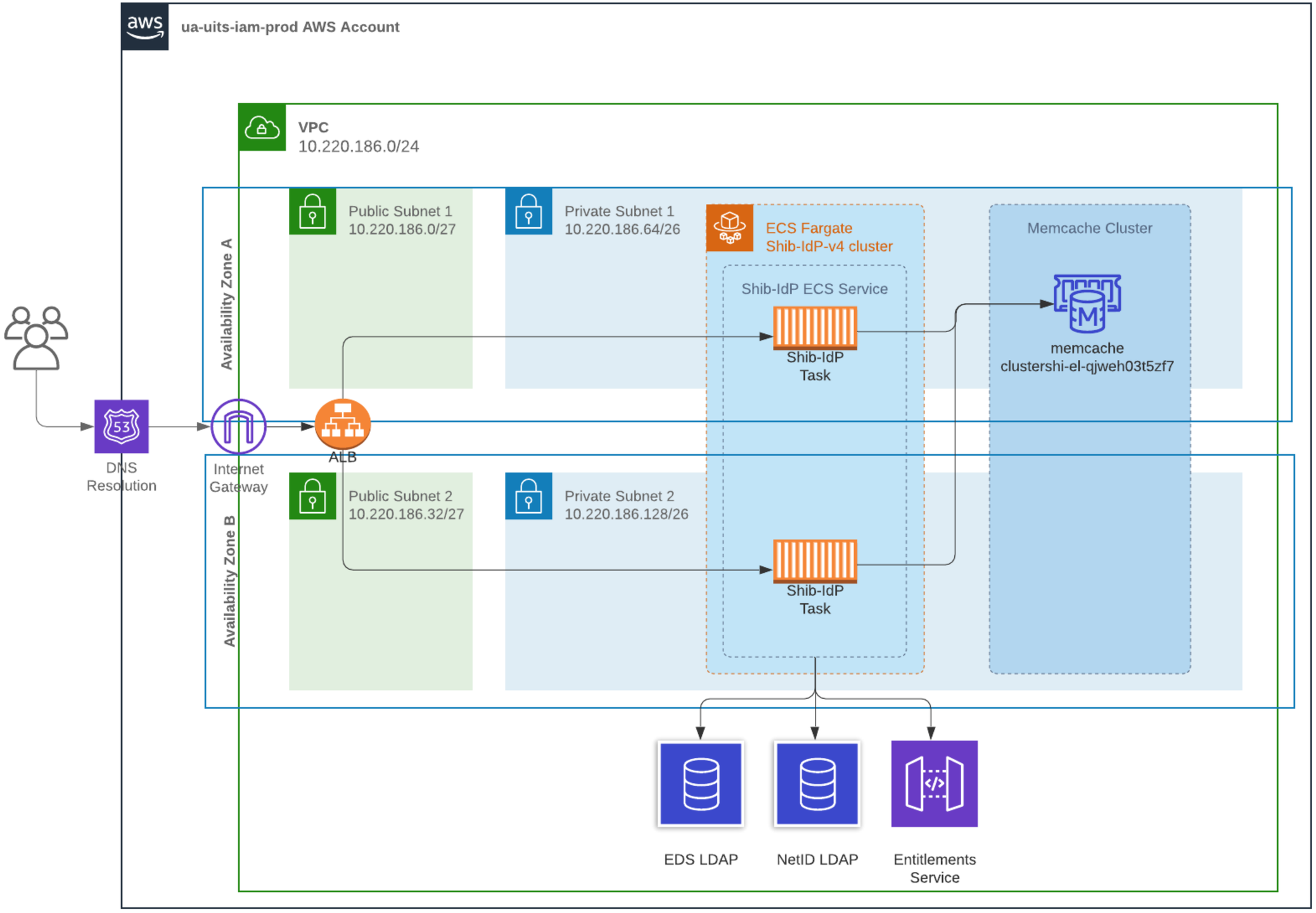
## Chat API Back End



# Cloud Architectures

## Shibboleth / WebAuth Architecture Diagram

- How about a more robust service, like the main campus WebAuth Identity Provider?
- Services Involved
  - Application Load Balancer
  - Elastice Container Service (ECS)
  - AWS ElastiCache (memcache)
  - VPC Subnets and Availability Zones


ua-uits-iam-prod AWS Account
VPC
10.220.186.0/24
Availability Zone A
Public Subnet 1
10.220.186.0/27
Private Subnet 1
10.220.186.64/26
ECS Fargate
Shib-IdP-v4 cluster
Shib-IdP ECS Service
Shib-IdP
Task
Memcache Cluster
memcache
clustershi-el-qjweh03t5zf7
DNS
Resolution
Internet
Gateway
ALB
Availability Zone B
Public Subnet 2
10.220.186.32/27
Private Subnet 2
10.220.186.128/26
Shib-IdP
Task
EDS LDAP
NetID LDAP
Entitlements
Service

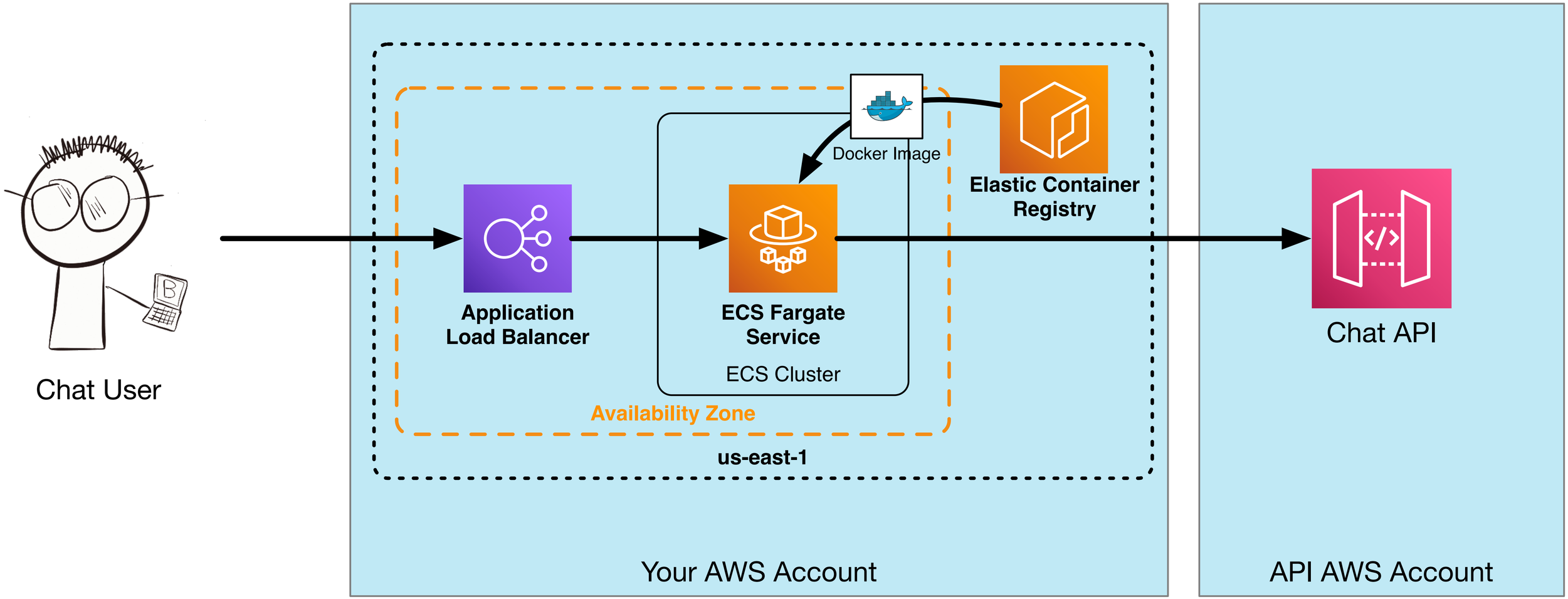
# Cloud Architectures

## Chat App v2

- How could we improve our initial Chat App architecture?
- Elastic Container Service
  - No EC2 instance to manage
  - Use Elastic Container Registry to store and retrieve Docker Images
- Application Load Balancer
  - Scale to multiple back end containers
  - Allow for easier SSL/TLS termination

# Cloud Architectures

## Chat App v2 Architecture



# Application Load Balancer & Elastic Container Service

# Application Load Balancer

- Public HTTP Endpoint
- Distribute incoming requests to multiple back-end processes
- HTTPS / SSL termination
- PaaS - AWS worries about patching and scaling
- Can perform some basic routing based on paths or protocols
  - Incoming HTTP → HTTPS
  - Static files to S3, dynamic requests to code

# Elastic Container Service

- Runs Docker containers
- Stores Docker images
- Automatically maps load balancer to container ports
- Can be configured to scale the number of back end containers
- Can run on a managed set of EC2 instances, or completely serverless with Fargate

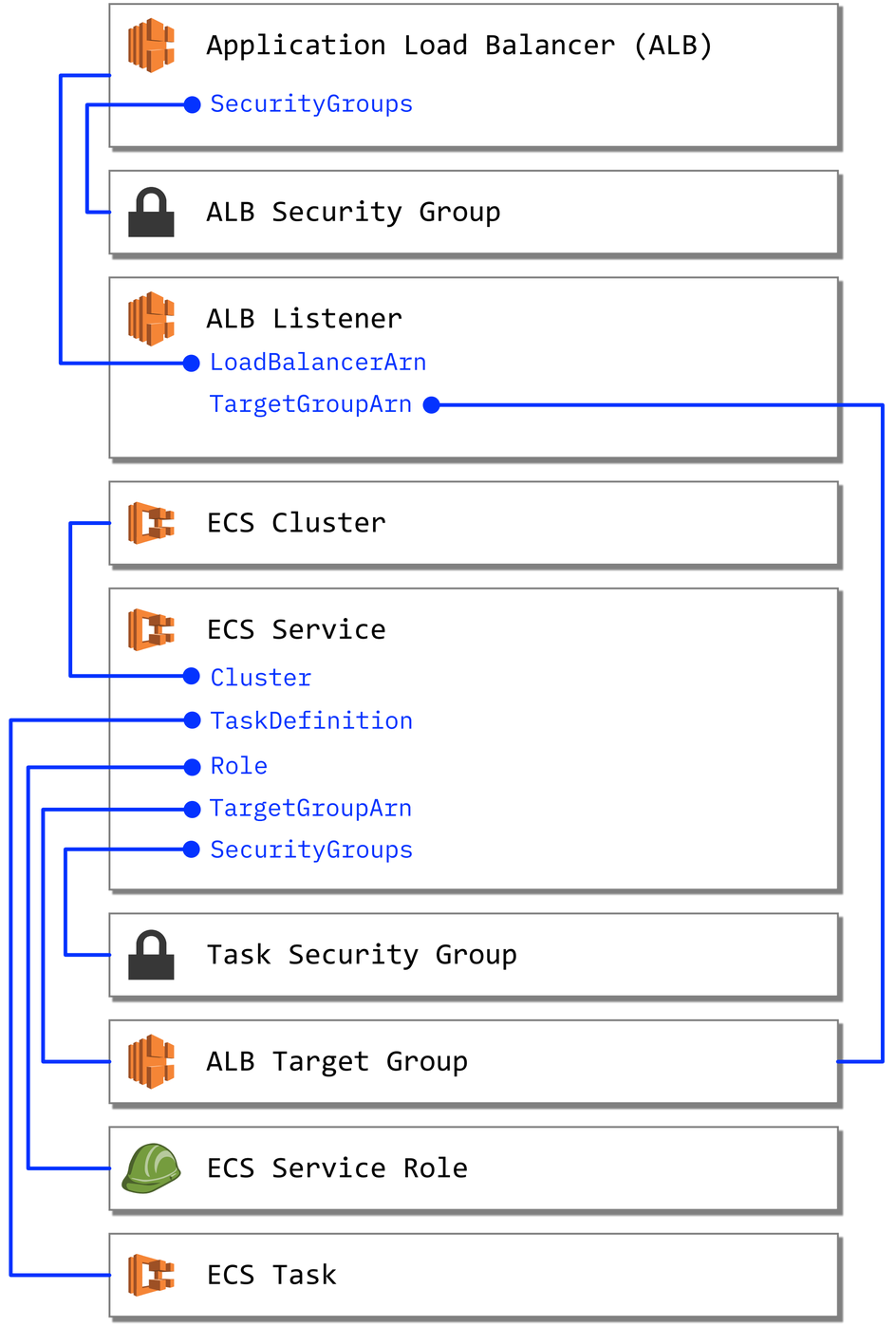
# Application Load Balancer & Elastic Container Service

## Demo

# ALB & ECS

## Automation?

- Many resources needed
- Possible by hand, but many chances to make mistakes
- Infrastructure as Code to the rescue
- CloudFormation Template



# CloudFormation

## ALB + ECS Template

- Parameters
  - Inputs to the template
  - By abstracting out parameters, a single template can be deployed multiple times and in multiple accounts

```
AWSTemplateFormatVersion: "2010-09-09"
Description: "iam-admin"

Metadata:
  cfn-lint:
    config:
      regions:
        - us-west-2
      ignore_checks:
        - I3042

Parameters:
  DockerImage:
    Type: String

  LabRoleARN:
    Type: String

  VpcId:
    Type: AWS::EC2::VPC::Id

  SubnetIds:
    Type: List<AWS::EC2::Subnet::Id>

  AcmCertificateArn:
    Type: String


Resources:
  LoadBalancer:
```

# CloudFormation

## ALB + ECS Template

- All these parameters will be unique to each account
- You will need to look up these values for your account

```
AWSTemplateFormatVersion: "2010-09-09"
Description: "iam-admin"

Metadata:
  cfn-lint:
    config:
      regions:
        - us-west-2
      ignore_checks:
        - I3042

Parameters:
  DockerImage:
    Type: String

  LabRoleARN:
    Type: String

  VpcId:
    Type: AWS::EC2::VPC::Id

  SubnetIds:
    Type: List<AWS::EC2::Subnet::Id>

  AcmCertificateArn:
    Type: String


Resources:
  LoadBalancer:
```

# CloudFormation

## Load Balancer

- To create an Application Load Balancer, we need to know what security group to attach to it, and what subnets it belongs to.
- SubnetIds comes from our input Parameters
- Security Group is defined in this template and referenced here
- Other properties are hard-coded (type, scheme, etc)

```
    Type: String

  LabRoleARN:
    Type: String

  VpcId:
    Type: AWS::EC2::VPC::Id

  SubnetIds:
    Type: List<AWS::EC2::Subnet::Id>

  AcmCertificateArn:
    Type: String


Resources:
  LoadBalancer:
    Type: AWS::ElasticLoadBalancingV2::LoadBalancer
    Properties:
      SecurityGroups:
        - !Ref LoadBalancerSecurityGroup
      Scheme: internet-facing
      Subnets: !Ref SubnetIds
      IpAddressType: ipv4
      Type: application

  LoadBalancerHttpListener:
    Type: AWS::ElasticLoadBalancingV2::Listener
    Properties:
      DefaultActions:
        - Type: "redirect"
          RedirectConfig:
            Protocol: "HTTPS"
            Port: "443"
            Host: "#{host}"
```

# CloudFormation

## Listeners

- Since this is an HTTP endpoint, we need to specify which ports to listen on
- Port 80 listener redirects all traffic to port 443
- Port 443 listener sends requests to the Target Group
  - Linked to a Certificate from input Parameters

```
    IpAddressType: ipv4
    Type: application

LoadBalancerHttpListener:
  Type: AWS::ElasticLoadBalancingV2::Listener
  Properties:
    DefaultActions:
      - Type: "redirect"
        RedirectConfig:
          Protocol: "HTTPS"
          Port: "443"
          Host: "#{host}"
          Path: "/#{path}"
          Query: "#{query}"
          StatusCode: "HTTP_301"
    LoadBalancerArn: !Ref LoadBalancer
    Port: 80
    Protocol: "HTTP"

LoadBalancerHttpsListener:
  Type: AWS::ElasticLoadBalancingV2::Listener
  Properties:
    DefaultActions:
      - Type: forward
        TargetGroupArn: !Ref LoadBalancerTargetGroup
    LoadBalancerArn: !Ref LoadBalancer
    Port: 443
    Certificates:
      - CertificateArn: !Ref AcmCertificateArn
    Protocol: HTTPS

LoadBalancerTargetGroup:
  Type: AWS::ElasticLoadBalancingV2::TargetGroup
  Properties:
    TargetType: ip
```

# CloudFormation

## Target Group

- Target Group links the ALB and listener to an ECS service
- Needs to be attached to the same VPC that our ALB subnets are in
- Healthcheck is defined

```
    LoadBalancerArn: !Ref LoadBalancer
    Port: 443
    Certificates:
      - CertificateArn: !Ref AcmCertificateArn
    Protocol: HTTPS

LoadBalancerTargetGroup:
  Type: AWS::ElasticLoadBalancingV2::TargetGroup
  Properties:
    TargetType: ip
    TargetGroupAttributes:
      - Key: deregistration_delay.timeout_seconds
        Value: 30
    HealthCheckEnabled: true
    HealthCheckIntervalSeconds: 60
    HealthCheckPath: "/"
    HealthCheckPort: "80"
    HealthCheckProtocol: HTTP
    HealthCheckTimeoutSeconds: 5
    HealthyThresholdCount: 3
    Matcher:
      HttpCode: 200-299
    Port: 80
    Protocol: HTTP
    VpcId: !Ref VpcId
  DependsOn:
    - LoadBalancer

LoadBalancerSecurityGroup:
  Type: AWS::EC2::SecurityGroup
  Properties:
    GroupDescription: !Sub "${AWS::StackName} external security gro
    VpcId: !Ref VpcId
    SecurityGroupIngress:
```

# CloudFormation

## ALB Security Group

- Here's the security group referenced by the Application Load Balancer
- Needs to allow incoming traffic on ports 80 and 443

```
      Port: 80
      Protocol: HTTP
      VpcId: !Ref VpcId
    DependsOn:
      - LoadBalancer

  LoadBalancerSecurityGroup:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupDescription: !Sub "${AWS::StackName} external security gro
      VpcId: !Ref VpcId
      SecurityGroupIngress:
        - IpProtocol: "tcp"
          CidrIp: "0.0.0.0/0"
          ToPort: 80
          FromPort: 80
        - IpProtocol: "tcp"
          CidrIp: "0.0.0.0/0"
          ToPort: 443
          FromPort: 443
      SecurityGroupEgress:
        - IpProtocol: "-1"
          CidrIp: "0.0.0.0/0"

  TaskSecurityGroup:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupDescription: !Sub "${AWS::StackName} internal security gro
      VpcId: !Ref VpcId
      SecurityGroupIngress:
        - IpProtocol: "tcp"
          SourceSecurityGroupId: !Ref LoadBalancerSecurityGroup
          ToPort: 80
          FromPort: 80
      SecurityGroupEgress:
```

# CloudFormation

## ECS Task Group

- The security group that surrounds the Container Task only allows traffic from objects in the Load Balancer security group
- Principle of least privilege: Only allow in traffic you absolutely need to. Nothing besides the ALB needs to send traffic to the containers

```
        ToPort: 80
        FromPort: 80
      - IpProtocol: "tcp"
        CidrIp: "0.0.0.0/0"
        ToPort: 443
        FromPort: 443
    SecurityGroupEgress:
      - IpProtocol: "-1"
        CidrIp: "0.0.0.0/0"

TaskSecurityGroup:
  Type: AWS::EC2::SecurityGroup
  Properties:
    GroupDescription: !Sub "${AWS::StackName} internal security gro
    VpcId: !Ref VpcId
    SecurityGroupIngress:
      - IpProtocol: "tcp"
        SourceSecurityGroupId: !Ref LoadBalancerSecurityGroup
        ToPort: 80
        FromPort: 80
    SecurityGroupEgress:
      - IpProtocol: "-1"
        CidrIp: "0.0.0.0/0"

Cluster:
  Type: AWS::ECS::Cluster
  Properties:
    ClusterName: !Ref AWS::StackName

Service:
  Type: AWS::ECS::Service
  DependsOn:
    - LoadBalancerHttpListener
  Properties:
```

# CloudFormation

## ECS Cluster

- The ECS Cluster itself is a very simple resource. It's really just a named container for other things to be attached to

```
TaskSecurityGroup:
  Type: AWS::EC2::SecurityGroup
  Properties:
    GroupDescription: !Sub "${AWS::StackName} internal security gro
    VpcId: !Ref VpcId
    SecurityGroupIngress:
      - IpProtocol: "tcp"
        SourceSecurityGroupId: !Ref LoadBalancerSecurityGroup
        ToPort: 80
        FromPort: 80
    SecurityGroupEgress:
      - IpProtocol: "-1"
        CidrIp: "0.0.0.0/0"

Cluster:
  Type: AWS::ECS::Cluster
  Properties:
    ClusterName: !Ref AWS::StackName

Service:
  Type: AWS::ECS::Service
  DependsOn:
    - LoadBalancerHttpsListener
  Properties:
    Cluster: !Ref Cluster
    ServiceName: !Ref AWS::StackName
    DeploymentConfiguration:
      MaximumPercent: 200
      MinimumHealthyPercent: 50
    DesiredCount: 1
    HealthCheckGracePeriodSeconds: 30
    LaunchType: FARGATE
    LoadBalancers:
      - ContainerName: !Sub "${AWS::StackName}-task"
```

# CloudFormation

## ECS Service

- An ECS Service defines an always-running set of container tasks
- Connects the ALB target group to actual containers
- FARGATE is the AWS serverless model for containers

```
Cluster:
  Type: AWS::ECS::Cluster
  Properties:
    ClusterName: !Ref AWS::StackName

Service:
  Type: AWS::ECS::Service
  DependsOn:
    - LoadBalancerHttpListener
  Properties:
    Cluster: !Ref Cluster
    ServiceName: !Ref AWS::StackName
    DeploymentConfiguration:
      MaximumPercent: 200
      MinimumHealthyPercent: 50
    DesiredCount: 1
    HealthCheckGracePeriodSeconds: 30
    LaunchType: FARGATE
    LoadBalancers:
      - ContainerName: !Sub "${AWS::StackName}-task"
        ContainerPort: 80
        TargetGroupArn: !Ref LoadBalancerTargetGroup
    NetworkConfiguration:
      AwsvpcConfiguration:
        Subnets: !Ref SubnetIds
        SecurityGroups:
          - !Ref TaskSecurityGroup
        AssignPublicIp: ENABLED
    TaskDefinition: !Ref TaskDefinition

TaskDefinition:
  Type: AWS::ECS::TaskDefinition
  Properties:
    Cpu: 512
    Memory: 1024
```

# CloudFormation

## ECS Task Definition

- The Task Definition defines all the properties for a given container, or set of containers
- Analogous to the docker run command
  - What image to run
  - What container port
  - Where do logs go
- ECS Service automatically maps host ports to the container port

```
          - !Ref TaskSecurityGroup
        AssignPublicIp: ENABLED
      TaskDefinition: !Ref TaskDefinition

  TaskDefinition:
    Type: AWS::ECS::TaskDefinition
    Properties:
      Cpu: 512
      Memory: 1024
      NetworkMode: awsvpc
      TaskRoleArn: !Ref LabRoleARN
      ExecutionRoleArn: !Ref LabRoleARN
      RequiresCompatibilities:
        - FARGATE
      ContainerDefinitions:
        - Name: !Sub "${AWS::StackName}-task"
          Image: !Ref DockerImage
          PortMappings:
            - ContainerPort: 80
          LogConfiguration:
            LogDriver: awslogs
            Options:
              awslogs-group: !Ref TaskLogGroup
              awslogs-region: !Ref AWS::Region
              awslogs-stream-prefix: "app"


  TaskLogGroup:
    Type: AWS::Logs::LogGroup
    DeletionPolicy: Delete
    UpdateReplacePolicy: Delete
    Properties:
      LogGroupName: !Sub "${AWS::StackName}-logs"
      RetentionInDays: 7
```

# CloudFormation

## Log Group

- Lastly we define a Log Group where the ECS task logs will be delivered
- By explicitly creating it, we can specify the retention policy
- If we let it be automatically created, logs stay around forever!

```
      ContainerDefinitions:
        - Name: !Sub "${AWS::StackName}-task"
          Image: !Ref DockerImage
          PortMappings:
            - ContainerPort: 80
          LogConfiguration:
            LogDriver: awslogs
            Options:
              awslogs-group: !Ref TaskLogGroup
              awslogs-region: !Ref AWS::Region
              awslogs-stream-prefix: "app"


  TaskLogGroup:
    Type: AWS::Logs::LogGroup
    DeletionPolicy: Delete
    UpdateReplacePolicy: Delete
    Properties:
      LogGroupName: !Sub "${AWS::StackName}-logs"
      RetentionInDays: 7

Outputs:
  LoadBalancerDNSName:
    Value: !GetAtt LoadBalancer.DNSName
    Export:
      Name: !Sub "${AWS::StackName}-alb-dns-name"
```

# CloudFormation

## Outputs

- We want to get the DNS name of the load balancer, so we can point a friendly DNS entry at it
  - CNAME

```
            awslogs-group: !Ref TaskLogGroup
            awslogs-region: !Ref AWS::Region
            awslogs-stream-prefix: "app"


  TaskLogGroup:
    Type: AWS::Logs::LogGroup
    DeletionPolicy: Delete
    UpdateReplacePolicy: Delete
    Properties:
      LogGroupName: !Sub "${AWS::StackName}-logs"
      RetentionInDays: 7

Outputs:
  LoadBalancerDNSName:
    Value: !GetAtt LoadBalancer.DNSName
    Export:
      Name: !Sub "${AWS::StackName}-alb-dns-name"
```