



Spot ↔ OD Failover Strategies v0.2

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AGENDA

1. Important Note
2. Workload based on ONLY ASG
3. Workload based on EKS

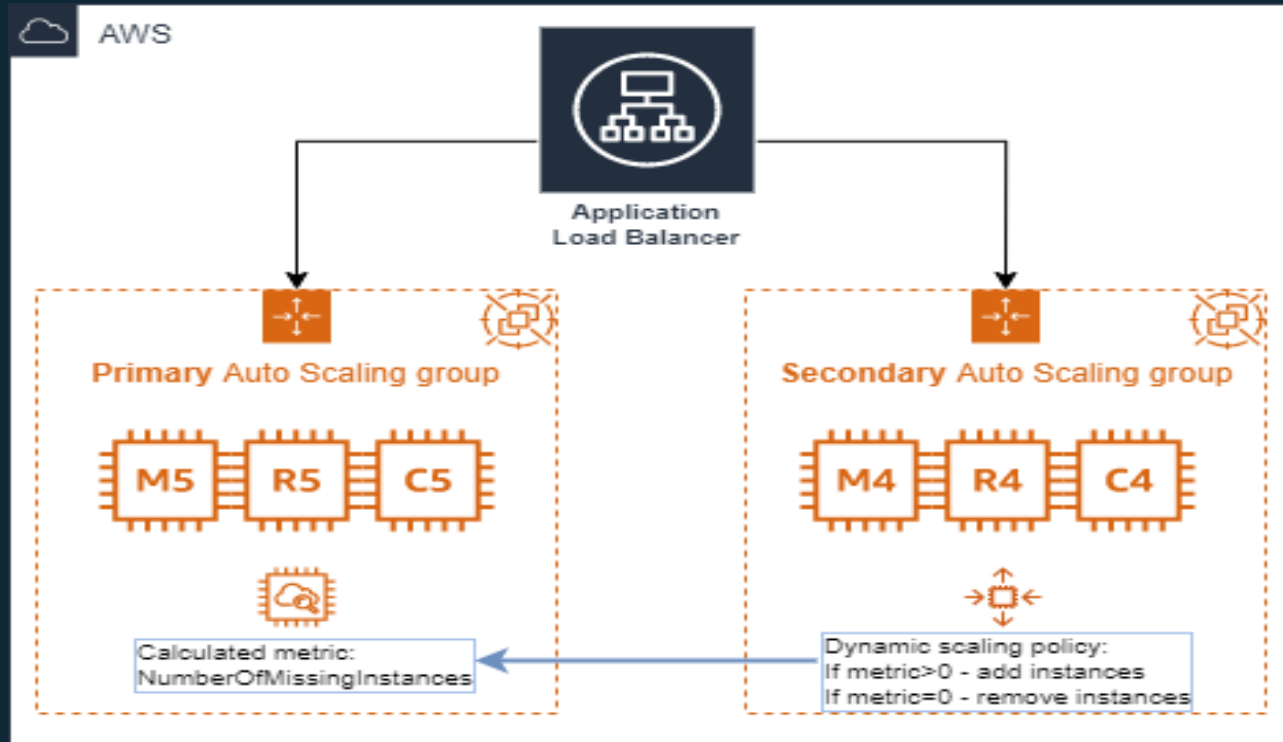
Important Note

- Please note it is always recommended to
 - use all of EC2 spot best practices
 - Run Stateless and Fault tolerant workloads on EC2 Spot
 - Ideal way is to design architectures considering potential delays for Replacement spot to be available if there are capacity constraints so you don't need failover strategies.
 - But if workload is very cost conscious or needs failover strategy for some reason, pls keep below considerations while adopting these approaches.
- Failover strategies are created ONLY based on many customer requests
- These are just few guidelines to implement your own strategy for as per your requirement
- These are NOT tested / proved for production. So request to please test it enough and own the solution before deploying on production



























Workload based on ONLY ASGs

ASG CWT Metrics Strategy

<https://medium.com/@ranshn/using-preferred-instance-types-availability-zones-or-purchase-options-with-ec2-auto-scaling-groups-1a5997f3cb0d>



Cloud Watch Metrics Math

Math expression 		Dynamic labels 		Statistic: Maximum 		Period: 1 Minute 		Remove all 	
<input type="checkbox"/>		Id	Label	Details	Statistic	Period	Y Axis	Actions	
<input checked="" type="checkbox"/>		e1	NumberOfMissingInstances	m2-m1			 		  
<input type="checkbox"/>		m1	GroupInServiceInstances	Auto Scaling • GroupInServiceInstances • AutoScalingGroupName: Coordinated ...	Maximum	1 Minute	 		  
<input type="checkbox"/>		m2	GroupDesiredCapacity	Auto Scaling • GroupDesiredCapacity • AutoScalingGroupName: CoordinatedSc...	Maximum	1 Minute	 		  



Cloud Watch Alarms

Threshold type



Static

Use a value as a threshold



Anomaly detection

Use a band as a threshold

Whenever NumberOfMissingInstances is...

Define the alarm condition



Greater

> threshold



Greater/Equal

>= threshold



Lower/Equal

<= threshold



Lower

< threshold

than...

Define the threshold value

0

Must be a number

▼ Additional configuration

Datapoints to alarm

Define the number of datapoints within the evaluation period that must be breaching to cause the alarm to go to ALARM state.

3

out of

3

OD ASG Scale Out/In Policies

Create scaling policy

Policy type

Simple scaling

Scaling policy name

ScaleDownWhenPrimaryIsOK

CloudWatch alarm

PrimaryASG-OK

Create a CloudWatch alarm

breaches the alarm threshold: PrimaryASG-OK ≤ 0 for 10 consecutive periods of 60 seconds where PrimaryASG-OK = m1-m2 for the metric dimensions:

m1 | AWS/AutoScaling • GroupDesiredCapacity • AutoScalingGroupName = CoordinatedScalingDemo-PrimaryASG

m2 | AWS/AutoScaling • GroupInServiceInstances • AutoScalingGroupName = CoordinatedScalingDemo-PrimaryASG

Take the action

Remove

20

Percent of group

Remove capacity units in increments of at least

1

capacity units

Cancel

Create

Create scaling policy

Policy type

Simple scaling

Scaling policy name

PrimaryASG-NotLaunchingInstances

CloudWatch alarm

PrimaryASG-NotLaunchingInstances

Create a CloudWatch alarm

breaches the alarm threshold: NumberOfMissingInstances > 0 for 3 consecutive periods of 60 seconds where NumberOfMissingInstances = m2-m1 for the metric dimensions:

m2 | AWS/AutoScaling • GroupDesiredCapacity • AutoScalingGroupName = CoordinatedScalingDemo-PrimaryASG

m1 | AWS/AutoScaling • GroupInServiceInstances • AutoScalingGroupName = CoordinatedScalingDemo-PrimaryASG

Take the action

Add

5

capacity units

Cancel

Create

Spot Interruption Handler

Dashboards

Alarms

ALARM 3

INSUFFICIENT 2

OK 7

Billing

Logs

Log groups

Insights

Metrics

Events

Rules

Event Buses

ServiceLens

Service Map

Traces

Synthetics

Canaries

Contributor Insights

Settings

Rules > spot-interruption-event

Actions

Summary

ARN ⓘ `arn:aws:events:us-east-1:000474600478:rule:spot-interruption-event`

Event pattern ⓘ

```
{  "source": [    "aws.ec2"  ],  "detail-type": [    "EC2 Spot Instance Interruption Warning"  ]}
```

Status Enabled

Description

Monitoring [Show metrics for the rule](#)

Targets

Filter:

⏪ < Viewing 1 to 2 of 2 Targets > ⏩

Type	Name	Input	Role	Additional parameters
SNS topic	awsajp_notification	Matched event		
Lambda function	ASG3_Spot_Interruption_Handler	Matched event		

Lambda Function

Lambda > Functions > ASG3_Spot_Interruption_Handler

ARN - arn:aws:lambda:us-east-1:000474600478:function:ASG3_Spot_Interruption_Handler 

ASG3_Spot_Interruption_Handler

Throttle

Qualifiers ▼

Actions ▼

ec2spotfullfilmentevent ▼

Test

Save

Configuration

Permissions

Monitoring

▼ Designer



ASG3_Spot_Interruption_Handler



Layers

(0)



CloudWatch Events/EventBridge

(2)

+ Add destination

+ Add trigger

Detach Instance from ASG

<https://aws.amazon.com/blogs/compute/running-web-applications-on-amazon-ec2-spot-instances/>

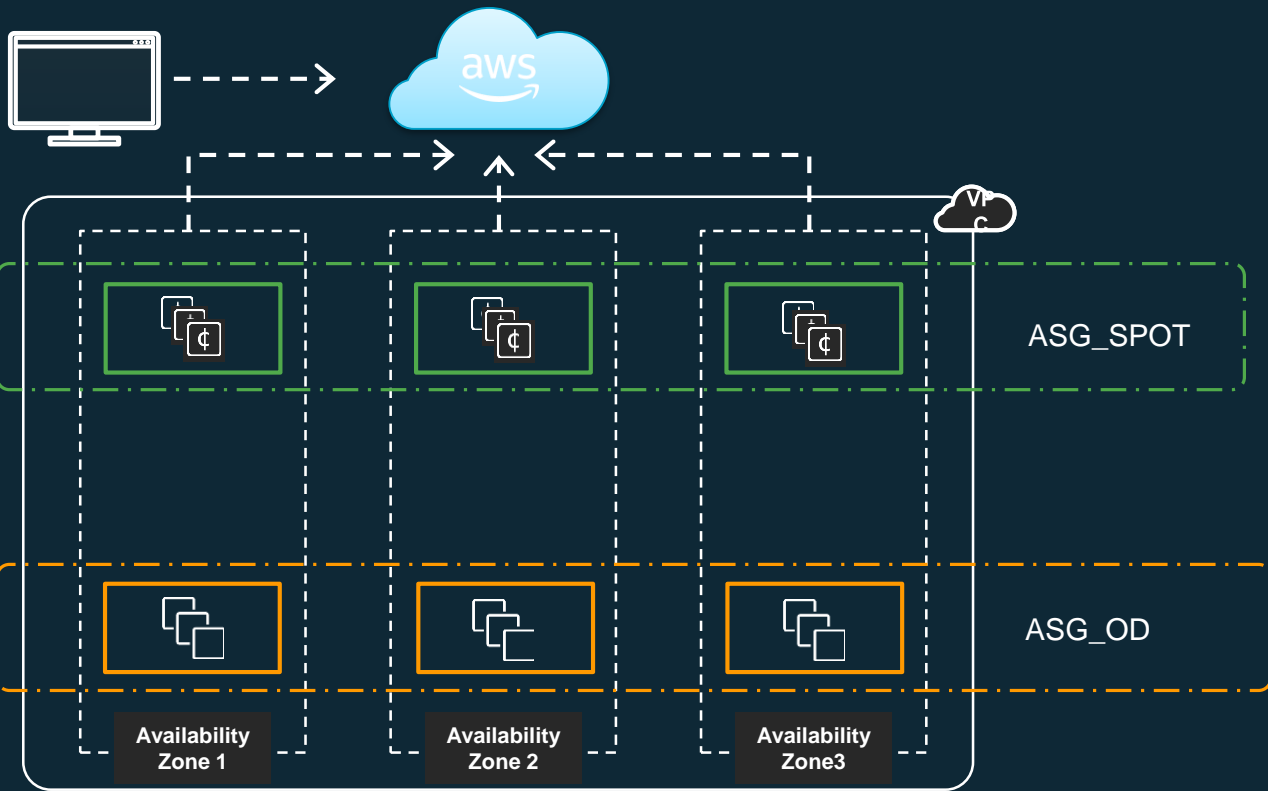
```
def detach_instance_from_asg(instance_id, as_group_name):  
    try:  
        # detach instance from ASG and launch replacement instance  
        response = asgclient.detach_instances(  
            InstanceIds=[instance_id],  
            AutoScalingGroupName=as_group_name,  
            ShouldDecrementDesiredCapacity=False)  
        logger.info(response['Activities'][0]['Cause'])  
    except ClientError as e:  
        error_message = "Unable to detach instance {id} from AutoS  
            id=instance_id, asg_name=as_group_name)  
        logger.error( error_message + e.response['Error']['Message']  
        raise e
```

Spot ↔ OD Failover Strategy

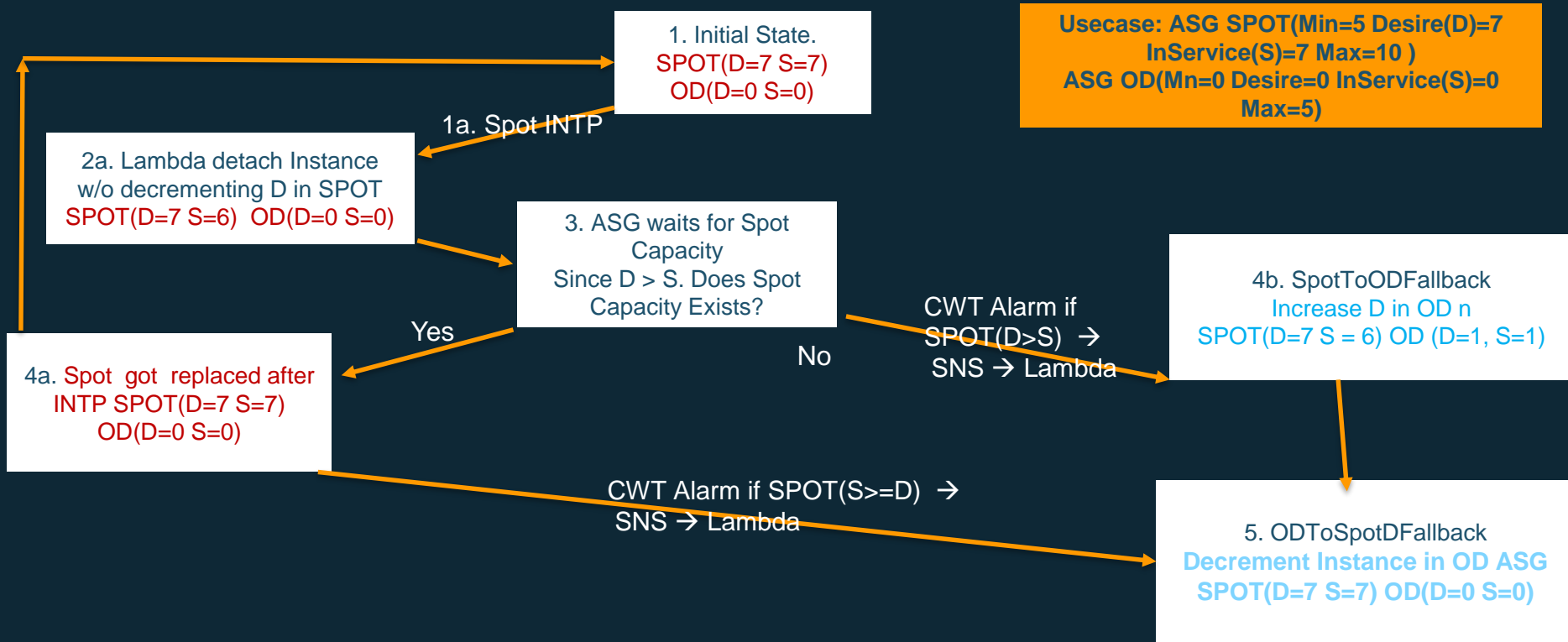
CW Event: E2 Spot Instance
Interruption Warning
CW Alarms based on Desired
and InService Count



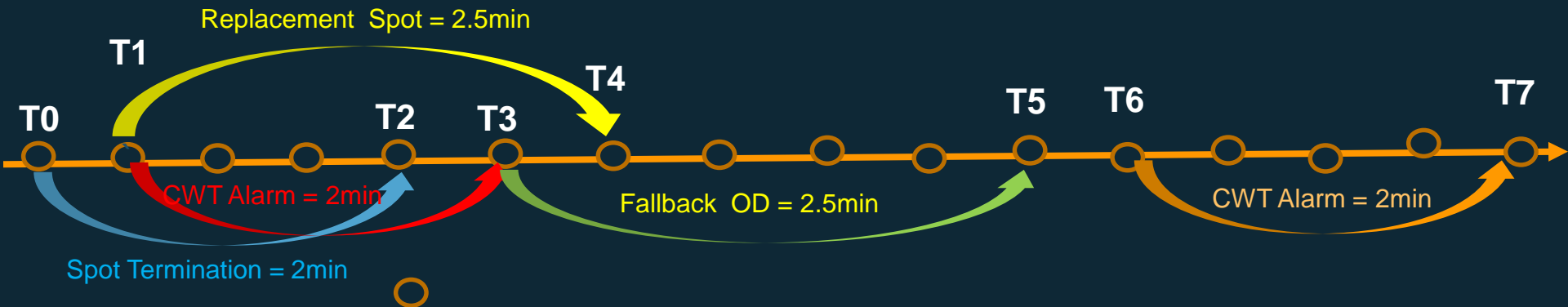
Scale OUT/IN



ASG Spot \leftrightarrow OD Fallback Strategy



ASG Spot \leftrightarrow OD Failover Timeline



T0 - Spot INTIP occurs

T0 - CWT Event \rightarrow lambda

T0 - ASG detaches the Instance

T1 = T0+30se (appx) = ASG tries to bring replacement instance

T2 = T0+2min = Spot is Terminated

T3 = T1+2min = CWT Alarm triggers for SpotToOD fallback \rightarrow Launches OD Instance

T4 = T1+2.5min(approx.) = Replacement Spot if ASG find capacity at T1

T5 = T3+2.5min(approx.) = Fallback OD launched at T3

T5 = T3+2.5min(approx.) = Fallback OD launched at T3

T6 = T1 + 5min = Replacement came back

T7 = T6 + 1 min = CWT alarm for ODtoSpot Fallback \rightarrow Terminating OD Instance

Workloads based on EKS

K8S CA ASGs/NGs Strategy

	Option #1: Separate ASG for Spot and OD	Option #2: Single ASG for Spot and OD	Comments
Labels/Taints to Spot/OD Instances	Different since each NG can be different settings	Same since they inherit from same ASG	Use Bootstrapping.sh to make it diff in Option 2
Scaling Speed	Low	High	Num of NGs affect CA scan simulations
Cost Optimization	Higher with high priority for spot and Spot to OD fallback leveraged	High	
Spot to OD fallback	Easy with priority expander. Ensure OD also scales. Fine tune <i>--max-node-provision-time</i>	N/A. Very difficult to automate. Not recommended	
Split Instances across Spot / OD	Not Simple. Tweak to Desire/min/max in ASGs	Easy. Use OD base and Percent options	
Pods Scheduling using labels/taints	Works well if labels/taints applied accordingly	Works well if labels/taints applied accordingly	No difference
Recommended Expander Strategy	Priority if both spot to OD fallback and scaling on OD is needed else Random bcz there is only spot	Random	
Usecase: Base on OD and Scale on Spot. Desire 10, Min 2, Max 20	OD_NG1: Desire=2, Min=2, Max=2 OR OD_NG2: Desire=1, Min=1, Max=1 SPOT_NG1: Desire=8, Min=0, Max=18 SPOT_NG2: Desire=4, Min=0, Max=9 CA scales only SPOT_NG1 and SPOT_NG2	SPOT_OD_NG1: Desire=10, Min=2, Max=20 OD_base=2, Percent=0% SPOT_OD_NG2: Desire=0, Min=0, Max=9 OD_base=0, Percent=0% CA scales on SPOT_OD_NG1 and SPOT_OD_NG2	NG1 with m5.large NG2 with m5.2xlarge OD_NG* can be managed NG

ASG/NG Config

- on-demand NG with lower priority
- Spot NG with higher priority
- *s--max-node-provision-time* (default 15 min)
- Stops considering NG in simulations
→ attempt to scale up a different NG if pods still pending
- Attempt to remove any nodes left unregistered after this time

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: cluster-autoscaler-priority-expander
data:
  priorities: |-
    10:
      - .*high-cost-guaranteed-instances.*
      - .*medium-cost-instances.*
    50:
      - .*low-cost-spot-instances.*
```

EKS CA Spot ↔ OD Fallback Strategy

Usecase: ASG SPOT(Min=5 Desire(D)=7 InService(S)=7 Max=10)
ASG OD(Mn=0 Desire=0 InService(S)=0 Max=5)

1. Initial State.
SPOT(D=7 S=7)
OD(D=0 S=0)

1a. Spot INTP

1b. Pending Pods →
CA Scale Up

2a. Lambda detach Instance
w/o decrementing D in SPOT
SPOT(D=7 S=6) OD(D=0 S=0)

2b. CA increases D in SPOT
SPOT(D=8 S=7) OD(D=0 S=0)

3. ASG waits for Spot Capacity
Since D > S. Does Spot
Capacity Exist?

No

4b. SpotToODFallback
CA increase D in OD n
decreases D back in SPOT (bcz NO
pending pods anymore)
SPOT(D=7 S=7) OD(D=1, S=1)

Yes

6. Increase D in SPOT and set
ODToSpotFallbackSSMFlag=TRUE
SPOT(D=8 S=7)
OD(D=1 S=1)

4a. IF

ODToSpotFallbackSSMFlag=TRUE
Terminate Instance in OD.
SPOT(D=8 S=8) OD(D=0 S=0) and set
ODToSpotFallbackSSMFlag=FALSE
ELSE Best Case. Nothing to Do. Spot
immediately got replaced after INTP
SPOT(D=7 S=7) OD(D=0 S=0)

5. CWT alarm OD(D>0) → SNS → Lambda
IF SPOT(D == S) then ODToSpotFallback
ELSE if SPOT(D > S) No action since state is
already #3 and wait for next alarm

CWT alarm
Triggers again
after a while If
OD(D>0)



Usecase and ASG / CA Config

- Usecase Description:
 - 100% scale on Spot. Use OD only for fallback until spot is available to maximize cost savings
 - Min number of Instance in Cluster running all the time is 5
 - Max number of Instance in Cluster is 10. Current / Desired Instances say 7
- ASG / NG Configuration
 - ASG SPOT Configuration
 - Min=5 Desire(D)=7 InService(S)=7 Max=10
 - ASG OD
 - Min=0 → bcz OD is meant ONLY for fallback and no need of any minimum OD instances.
 - Desire=0 → Assume we have required number of Spot instances. No need of any OD for initially.
 - InService(S)=0 is same as Desired
 - Max=5 → i.e. to implement fallback ONLY for min of SPOT ASG i.e. 5. Ideally OD Max should be same as SPOT Max to implement fallback for ALL Spot Instances not just min spot instances
- CA Config
 - Priority expander strategy. SPOT ASG is higher priority than OD ASG
 - Set *--max-node-provision-time* to lesser value say 3min or 5min (default is 15 min)

Sequence of Events Description - 1

1. This is initial state of the ASG
2. There can be two options
 - 2a. Spot Interruption occurs
 - Lambda is triggered upon on spot interruption notification
 - Lambda calls detach API of ASG for this spot instance
 - Instance is taken out of ASG and kept in the draining mode
 - ASG will try to get the replacement spot immediately
 - 2b. CA scaling up occurs bcz there are some pending pods in the cluster
 - CA will increment the desired capacity of Spot ASG by 1
 - In both 2a and 2b, the desired capacity is more than number of instances in Service.
3. ASG waits for spot capacity to launch a new instance

Sequence of Events Description - 2

4. There can be two options

- 4a. spot capacity is available.
 - There can be two options
 - ODTToSpotFallbackSSMFlag is TRUE
 - In this case, decrement Instance in OD ASG and set the flag to FALSE
 - ODTToSpotFallbackSSMFlag is FALSE
 - That means it is a normal spot interruption
- 4b . Spot is not available
 - CA will fallback to OD ASG

5. CWT alarm triggers if there are instances running in the Ondemand ASG

- There are two options
- If desired and InService capacity is same in Spot ASG, then implement
- Else if desiredCount > InService instances, then SPOT ASG is already waiting for spot, so no need to do anything

6. ODTToSpotFallback

- Increase the desired capacity in Spot ASG



Thank you

<https://aws.amazon.com/ec2/spot>