15-319 / 15-619 Cloud Computing

Recitation 4

February 6th, 2017

Administrative Issues

- Make use of office hours
    - We will have to make sure that you have tried yourself before you ask
- Monitor AWS (and Azure / GCP) expenses regularly
- Always do the cost calculation before launching services
- Terminate your instances when not in use
- Stopping instances still has an EBS cost ($0.1/GB-Month)
- Make sure spot instances are tagged right after launch

Important Notice

- **DON'T EVER EXPOSE YOUR AWS CREDENTIALS!**
    - **Github**
    - **Bitbucket**
    - **Anywhere public…**
- **DON'T EVER EXPOSE YOUR GCP CREDENTIALS!**
- **DON'T EVER EXPOSE YOUR Azure CREDENTIALS!**
    - **ApplicationId, ApplicationKey**
    - **StorageAccountKey, EndpointUrl**

Reflection

- Last week’s reflection
  - Project 1.2, Quiz 2
- Theme - **Big data analytics**
  - P1.1: Sequential Analysis of **100s MB** of wikipedia data
  - P1.2: Parallel Analysis of **35GB** compressed / **128GB** decompressed wikipedia data
- Power of parallel analysis
  - Amount of work done remains the same
  - Span is reduced significantly

Reflection

- You should have learned
  - How to process big data sets with MapReduce
    - How MapReduce works
    - How to write a Mapper and a Reducer
    - Performance/cost tradeoff
    - How to debug MapReduce
  - How to save overall cost by testing using small data sets
- Don’t forget about MapReduce just yet!
  - Will be relevant in the Team Project and Project 4

This Week

- **Quiz 3 (OLI Modules 5 & 6)**
  - Due on **Friday**, Feb 9th, 2018, 11:59PM ET

- **Project 2.1**
  - Due on **Sunday**, Feb 11th, 2018, 11:59PM ET

OLI Module 5 - Cloud Management

Cloud Software stack - enables provisioning, monitoring and metering of virtual user “resources” on top of the Cloud Service Provider’s (CSP) infrastructure.

- Cloud middleware
- Provisioning
- Metering
- Orchestration and automation
- Case Study: Openstack - Open-source cloud stack implementation

OLI Module 6 - Cloud Software Deployment Considerations

- Programming the cloud
- Deploying applications on the cloud
- Build fault-tolerant cloud services
- Load balancing
- Scaling resources
- Dealing with tail latency
- Economics for cloud applications

Project 2 Overview

Scaling and Elasticity with VMs, Containers & Functions

- **2.1 Scaling Virtual Machines**
  - Horizontal scaling in / out using AWS APIs
  - Load balancing, failure detection, and cost management on AWS
  - Infrastructure as Code (Terraform)
- **2.2 Scaling with Containers**
  - Building your own container-based services. Frontend and Backend services.
  - Docker containers
  - Manage multiple Kubernetes Cluster
  - Multi Cloud deployments
- **2.3 Functions as a Service**
  - Develop event driven cloud functions
  - Deploy multiple functions to build a video processing pipeline

Project 2.1 Learning Objectives

- **Design** solutions and invoke cloud APIs to programmatically provision and deprovision cloud resources based on the current load.
- **Explore** and compare the usability and performance of APIs used in AWS.
- **Configure** and deploy an Elastic Load Balancer along with an Auto Scaling Group on AWS.
- **Develop** solutions that manage cloud resources with the ability to deal with resource failure.
- **Account** for cost as a constraint when provisioning cloud resources and **analyze** the performance tradeoffs due to budget restrictions.
- **Experience** using cloud orchestration and automation tools such as Terraform.

Quality of Service (QoS)

Quantitatively Measure QoS

- Performance: Throughput, Latency
  (Very helpful in Projects 2 & Team Project)
- Availability: the probability that a system is operational at a given time *(Projects P2.1 and P2.2)*
- Reliability: the probability that a system will produce a correct output up to a given time *(Project P2.1 and P2.2)*

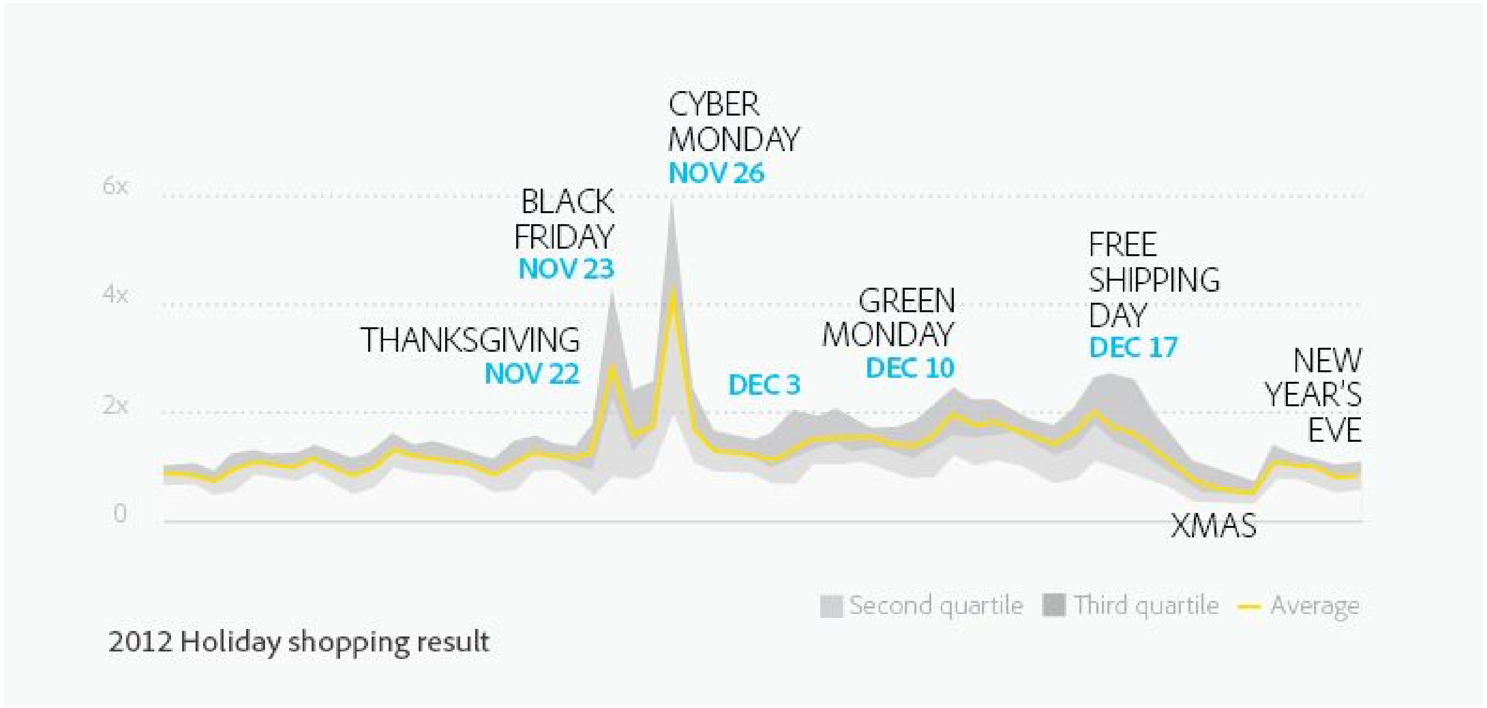
QoS Matters:

- Amazon found every 100ms of latency cost them 1% in sales.

FACT

Reality, human patterns...

- Daily
- Weekly
- Monthly
- Yearly
- ...

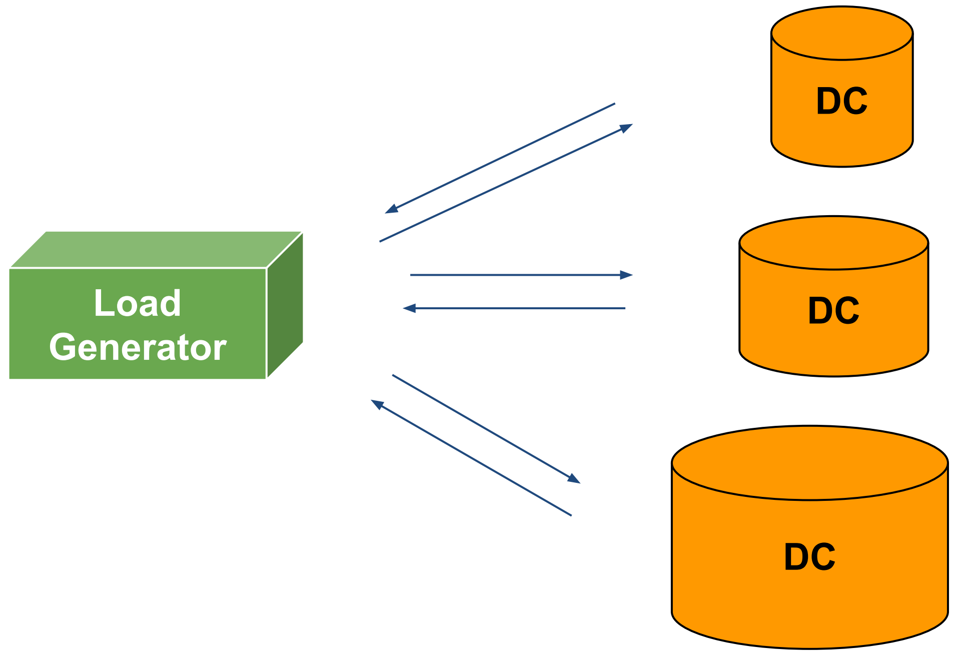


2012 Holiday shopping result

sapient.com

Cloud Comes to the Rescue!
Scaling!

P0: Vertical Scaling

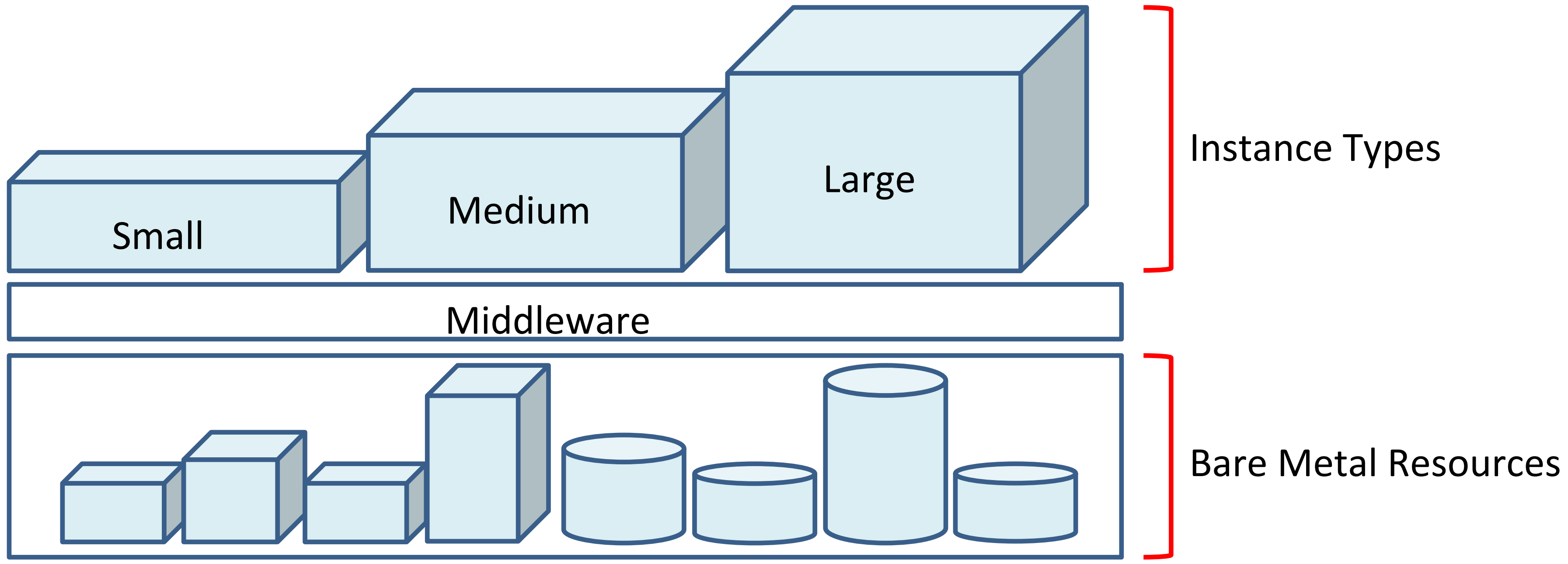


Small Data Center Instance
Serves 100 requests per second

Medium Data Center Instance
Serves 1000 requests per second

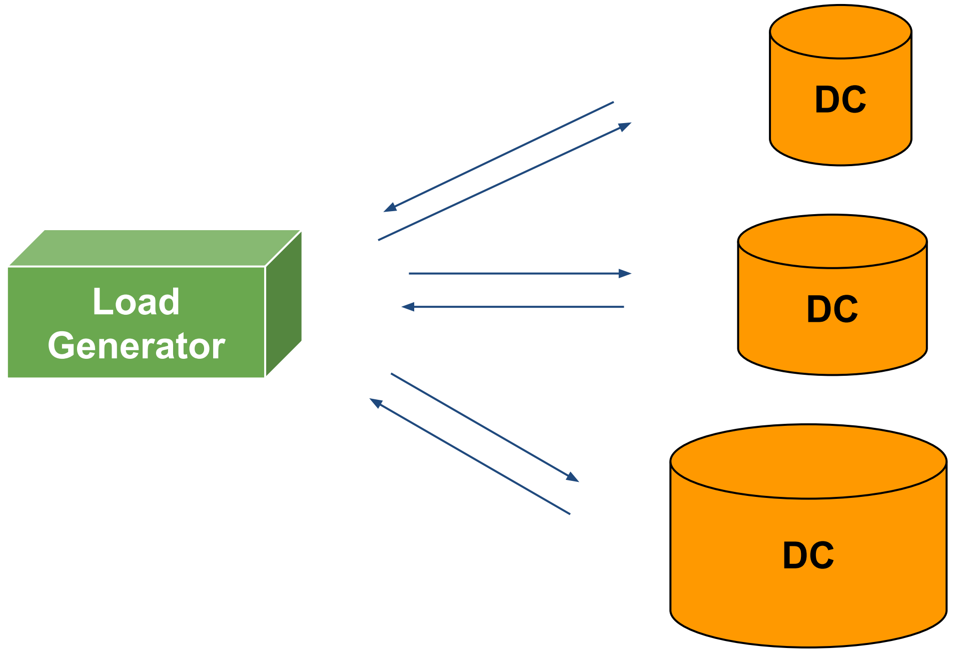
Large Data Center Instance
Serves 10000 requests per second

Resources in Cloud Infrastructure

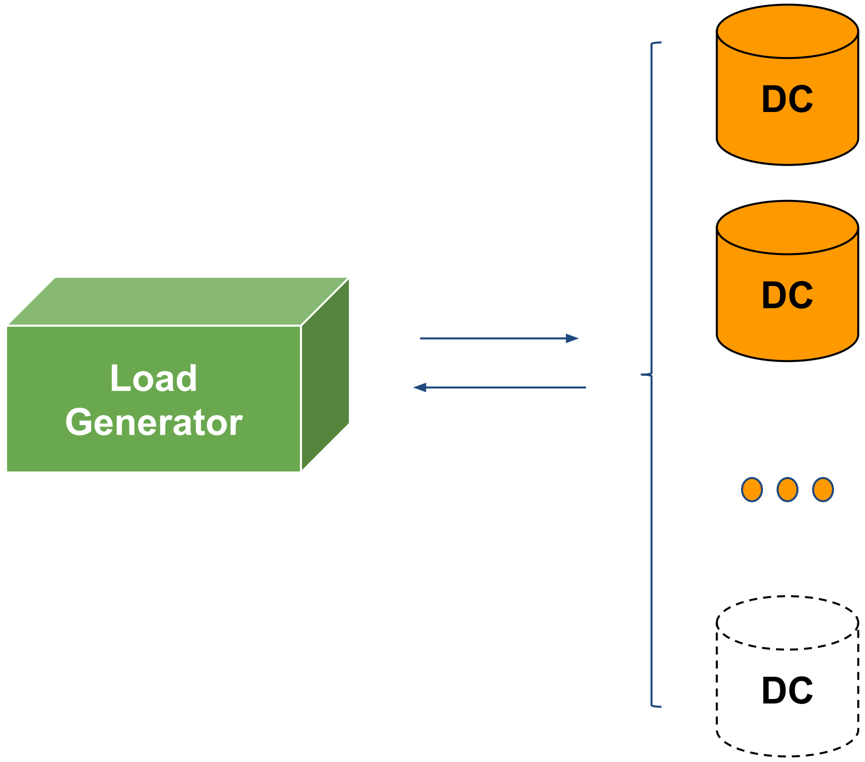


P0: Vertical Scaling Limitation

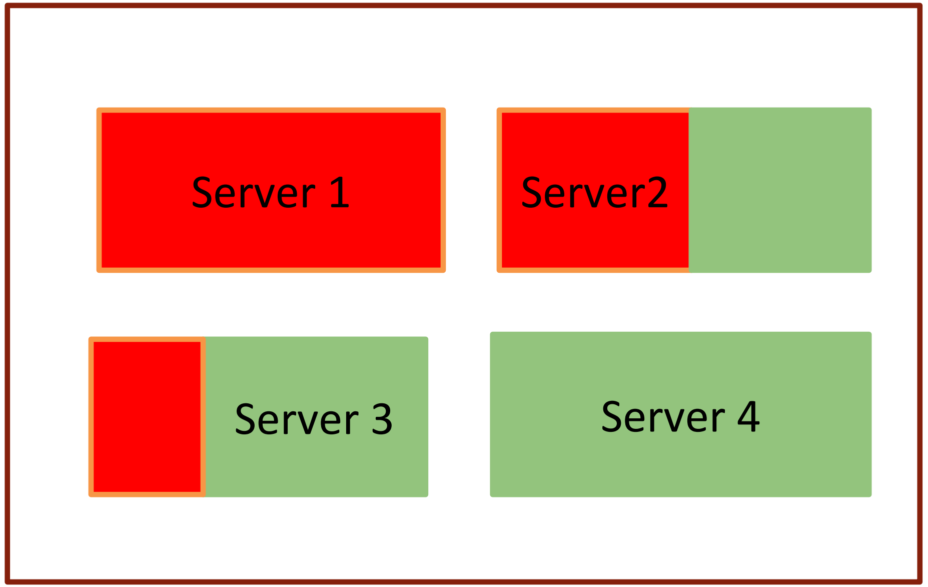
- However, one instance will always have limited resources.
- Reboot/Downtime.



Horizontal Scaling



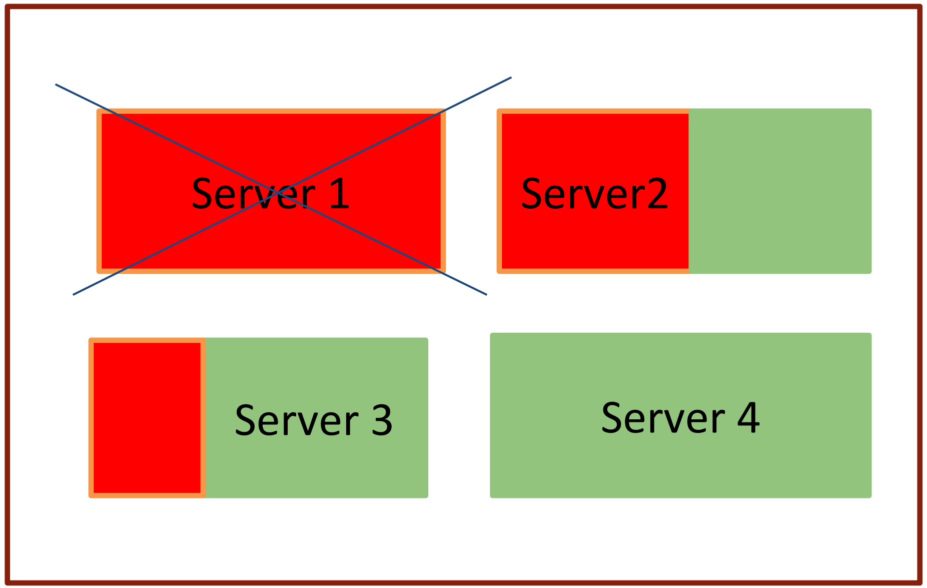
How do we distribute load?



🟥 CPU utilization, memory utilization…

🟩 Available capacity

Instance Failure?



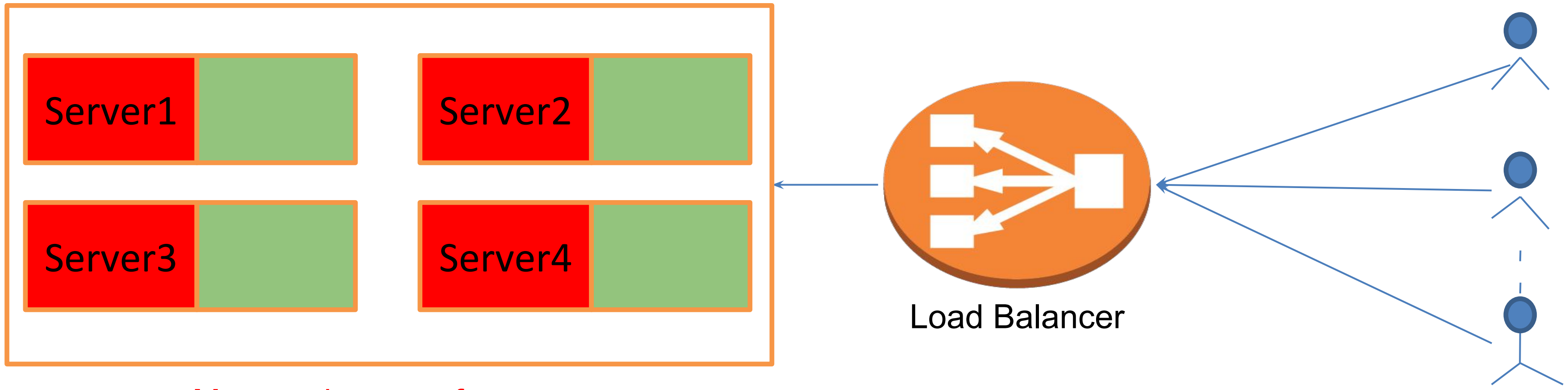
🟥 CPU utilization, memory utilization…

🟩 Available capacity

What You Need

- Make sure that workload is even on each server
- Do not assign load to servers that are down
- Increase/Remove servers according to changing load

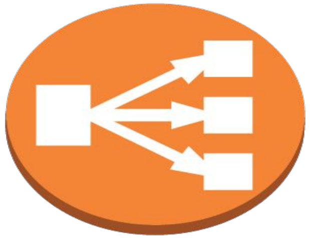
How does a cloud service help solve these problems?



Managed group of servers

Load balancer

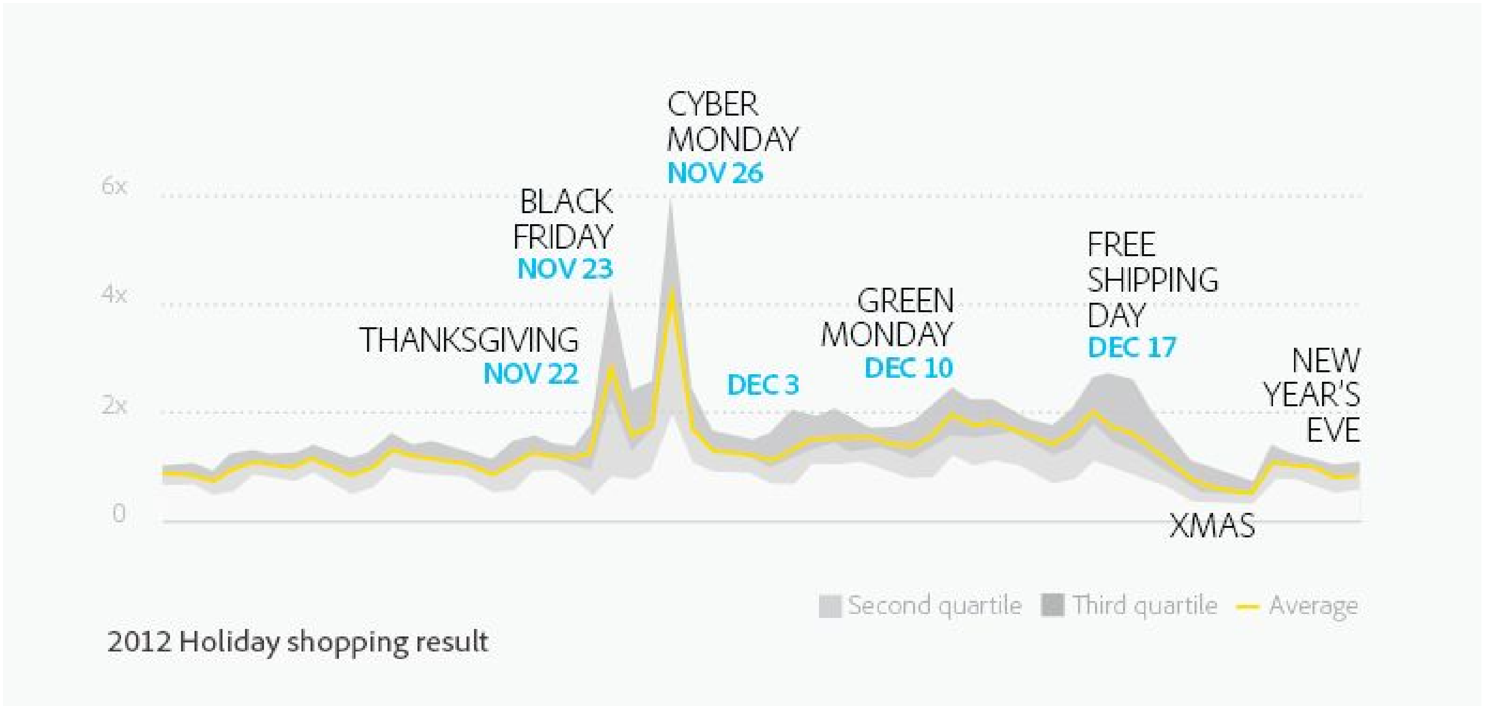
- “Evenly” distribute the load
- Simplest distribution strategy
  - Round Robin
- Health Check



Load Balancer

- What if the Load Balancer becomes the bottleneck?
  - Elastic Load Balancer
    - Could scale up based on load
  - Elastic, but it takes time
    - Through the warm-up process

Reality...



2012 Holiday shopping result

sapient.com

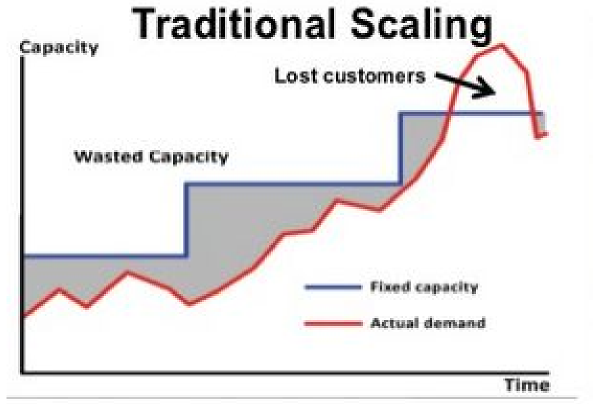
Scaling

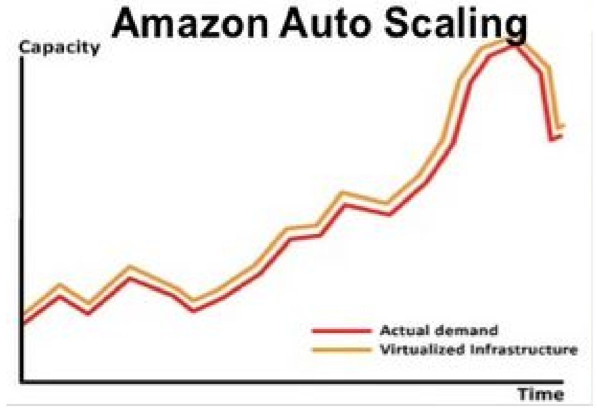
Manual Scaling:

- Expensive on manpower
- Low utilization or over provisioning
- Manual control
- Lose customers

Autoscaling:

- Automatically adjust the size based on demand
- Flexible capacity and scaling sets
- Save cost





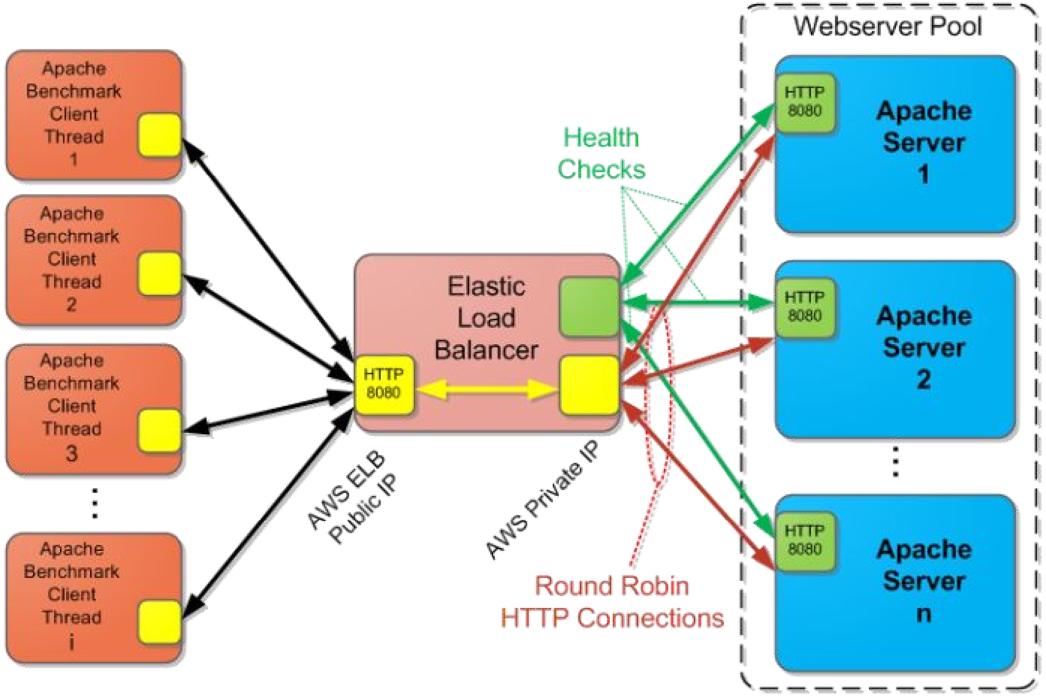
AWS Autoscaling

Auto Scaling on AWS

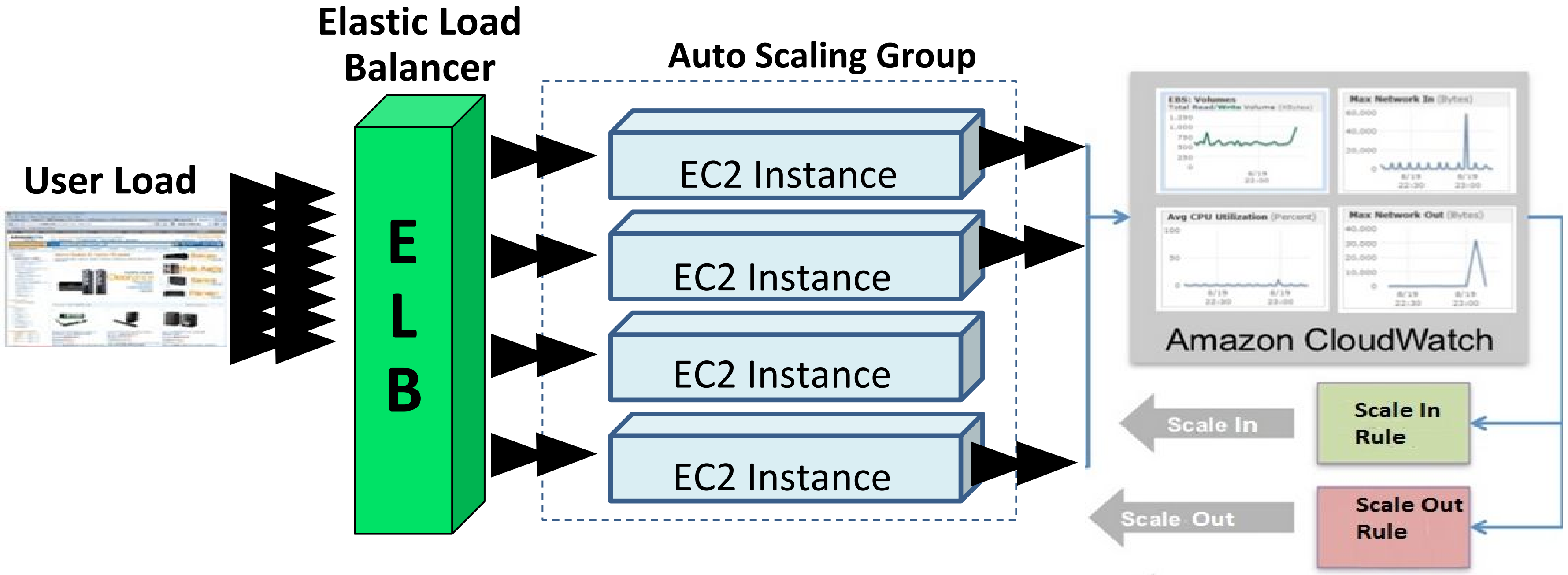
Using the AWS APIs:

- **CloudWatch**
- **ELB**
- **Auto Scaling Group**
- **Auto Scaling Policy**
- **EC2**

You can build a load balanced auto-scaled web service.

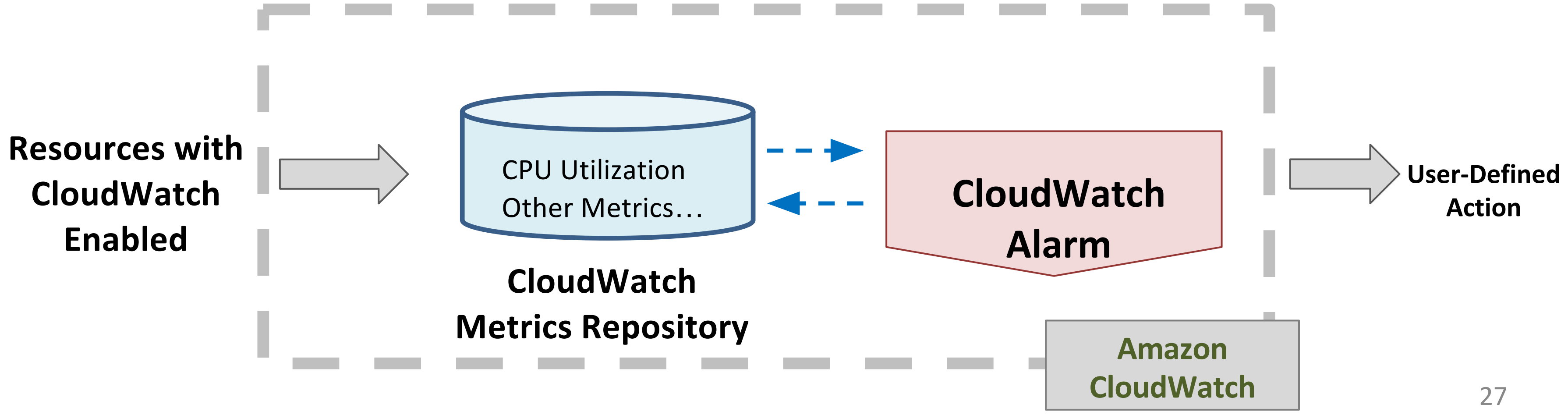


Amazon Auto Scaling Group



Amazon’s CloudWatch Alarm

- Monitor CloudWatch metrics for some specified alarm conditions
- Take automated action when the condition is met



Terraform Configuration

- **Providers**
  - A provider is responsible for understanding API interactions and exposing resources.
- **Resources**
  - The resource block defines a resource that exists within the infrastructure.
- **AWS Provider**
  - https://www.terraform.io/docs/providers/aws/index.html

```
$ cat main.tf

provider "aws" {
  region     = "us-east-1"
}

resource "aws_instance" "cmucc" {
  ami           = "ami-2757f631"
  instance_type = "t2.micro"

  tags {
    Project = "2.1"
  }

  key_name = "my-ssh-key"
}
```

Terraform CLI

- **init**
  - Initializes a working directory containing Terraform configuration files.
- **plan**
  - Creates an execution plan.
- **apply**
  - Apply the changes required to reach the desired state.
- **destroy**
  - Destroy the Terraform-managed infrastructure.

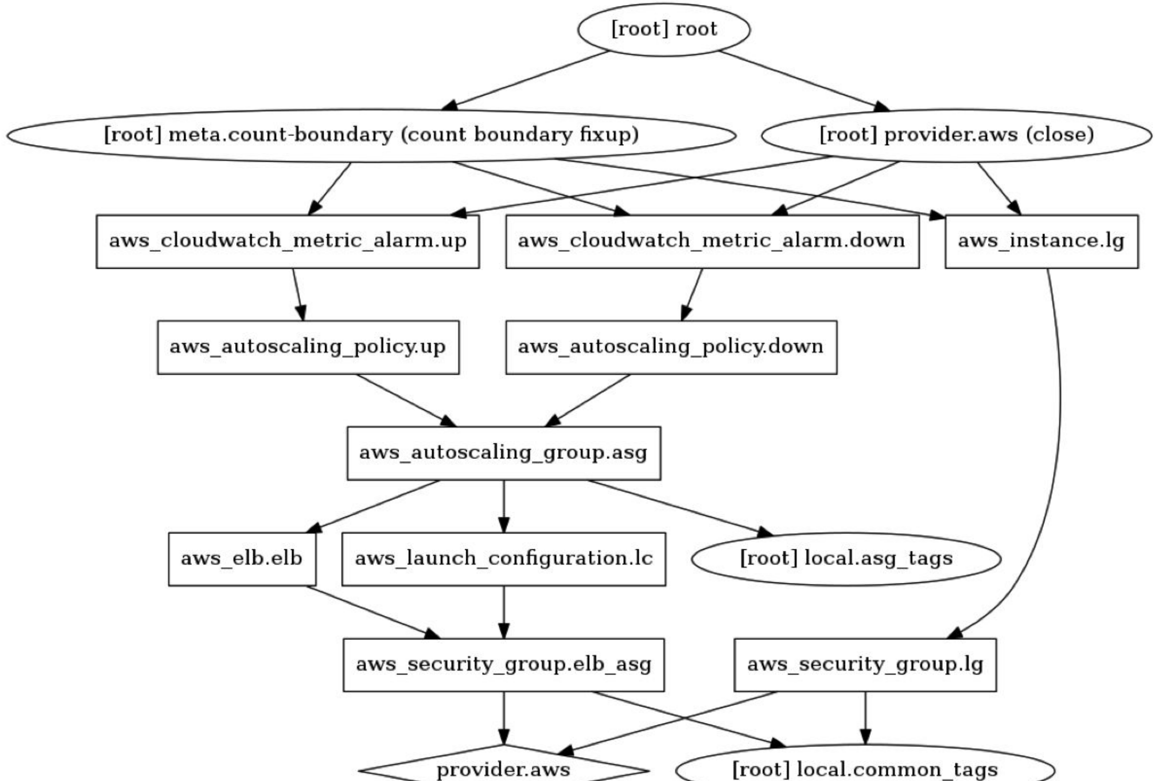
```
$ terraform plan
...
Terraform will perform the following actions:

  + aws_instance.cmucc
      id:                          <computed>
     ami:                          "ami-2757f631"
      ...

Plan: 1 to add, 0 to change, 0 to destroy.

$ terraform apply
...
```

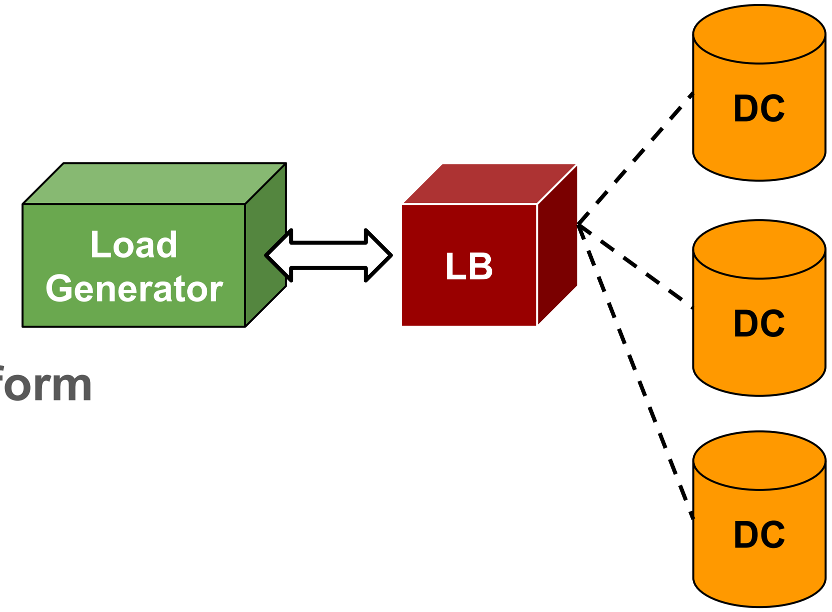
Declarative Infrastructures with Terraform


[root] root
[root] meta.count-boundary (count boundary fixup)
[root] provider.aws (close)
aws_cloudwatch_metric_alarm.up
aws_cloudwatch_metric_alarm.down
aws_instance.lg
aws_autoscaling_policy.up
aws_autoscaling_policy.down
aws_autoscaling_group.asg
aws_elb.elb
aws_launch_configuration.lc
[root] local.asg_tags
aws_security_group.elb_asg
aws_security_group.lg
provider.aws
[root] local.common_tags

Do not expect this to exactly match your solution (e.g. the load balancer is supposed to be an Application Load Balancer)!

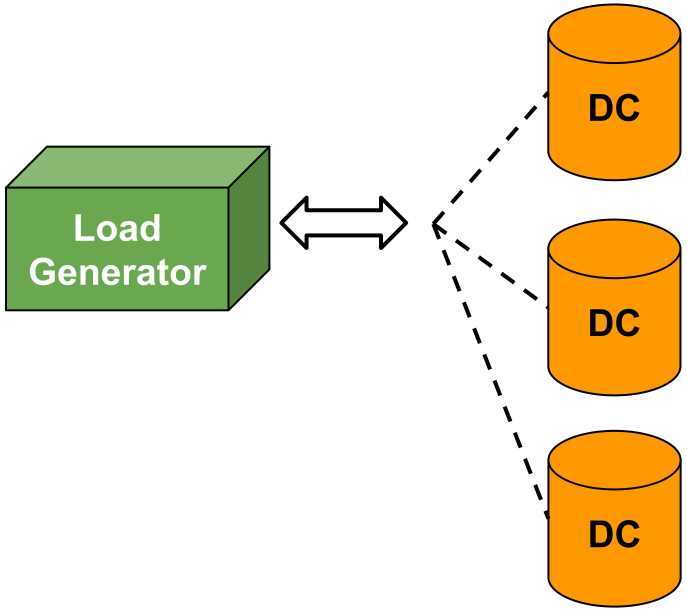
Project 2.1 Scaling on AWS

- Step 1
  - AWS Horizontal Scaling
- Step 2
  - AWS Auto Scaling
- Step 3
  - AWS Auto Scaling with Terraform



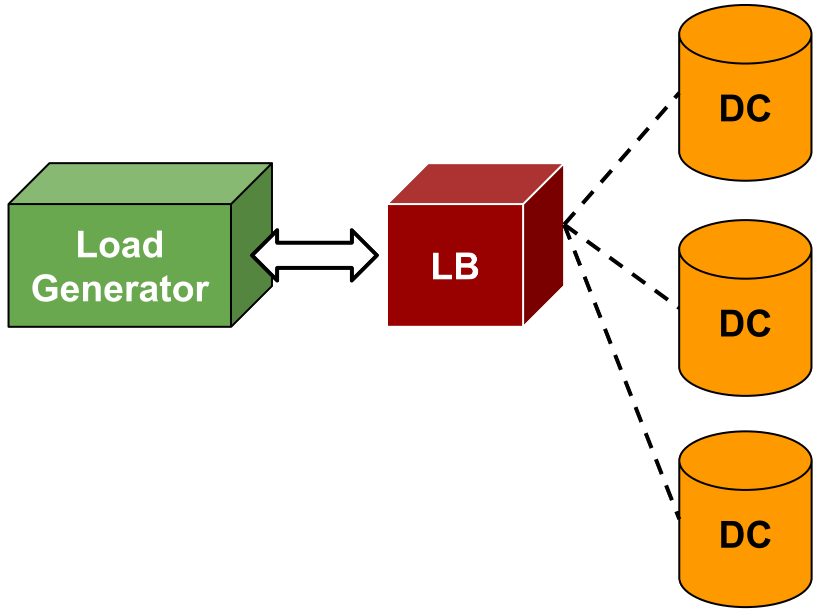
Project 2.1 Scaling on AWS

- Step 1 - AWS Horizontal Scaling
- Implement Horizontal Scaling in AWS.
- Write a program that launches the data center instances and ensures that the target total RPS is reached.
- Your program should be fully automated: launch LG->submit password-> Launch DC-> start test-> check log -> add more DC...



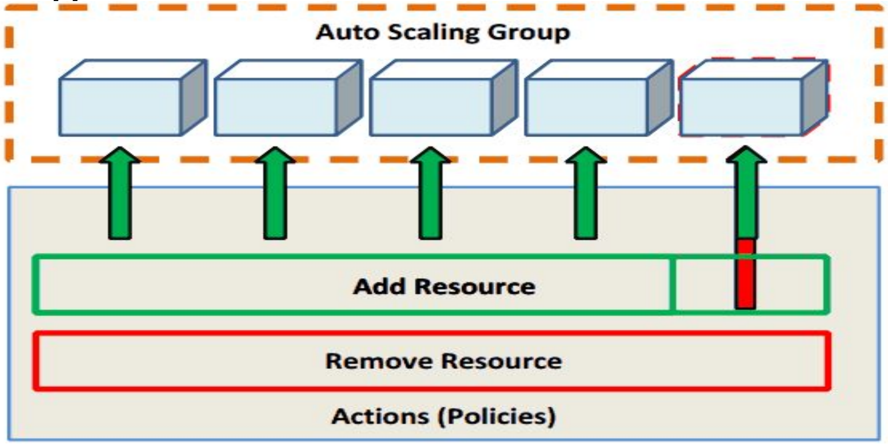
Project 2.1 Scaling on AWS

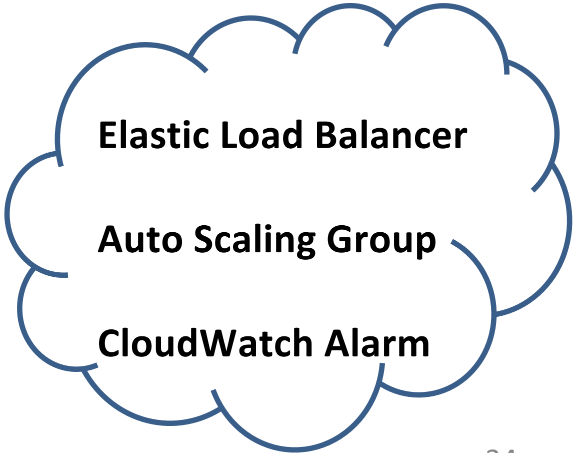
- **Step 2 - AWS Auto Scaling**



P2.1 - Step 2 - Your Tasks

- Programmatically create an Application Load Balancer (ALB) and an Auto Scaling Policy. Attach the policy to Auto-Scaling Group (ASG) and link ASG to ALB.
- Test by submitting a URL request and observe logs, ALB, and CloudWatch.
- Decide on the Scale-Out and Scale-In policies
- Mitigate failure





Hints for Project 2.1 AWS Autoscaling

Step 2 - AWS Auto Scaling

- Autoscaling Test could be very EXPENSIVE!
  - on-demand and charged by the hour
- Determine if there is a less expensive means to test your solution
- Creating and deleting security groups can be tricky
- CloudWatch and monitoring in ELB is helpful
- Explore ways to check if your instance is ready
- Understanding the API documents could take time
- Finish parts 1-3 first, the experience will help

Project 2.1 Scaling on AWS

- Step 3 - AWS Auto Scaling with Terraform
- Read the Infrastructure as Code primer to learn about infrastructure automation
- Update the started Terraform configuration to launch the AWS resource required for autoscaling (ALB, Alarms, ASG…)
- Remove the code to launch these resources (as they are in the TF config)
- Makes sure that **`terraform plan`** generates the expected resource

Project 2.1 Code Submission

AWS:

- Submit the horizontal scaling task on AWS’s load generator (LG) instance
- Submit the autoscaling task to the AWS load generator (LG) instance
- Submit the Terraform autoscaling task to the AWS load generator (LG) instance
    - You can use the test id from the AWS autoscaling task when creating the ZIP file

Penalties for 2.1

Violation	Penalty of the project grade
Spending more than $20 for this project phase on AWS	-10%
Spending more than $35 for this project phase on AWS	-100%
Failing to tag all your resources in either parts (EC2 instances, ELB, ASG) for this project with the tag: key=Project, value=2.1 (AWS only)	-10%
Submitting your AWS/Andrew credentials in your code for grading	-100%
Using instances other than t2.micro (testing only) or m3.medium for Horizontal scaling on AWS	-100%
Using instances other than t2.micro (testing only), m3.medium for Autoscaling on AWS	-100%
Submitting executables (.jar, .pyc, etc.) instead of human-readable code (.py,.java, .sh, etc.)	-100%

Penalties for 2.1 cont.

Violation	Penalty of the project grade
Attempting to hack/tamper the autograder in any way	-100%
Cheating, plagiarism or unauthorized assistance (please refer to the university policy on academic integrity and our syllabus)	-100%

AWS Cloud APIs

- AWS CLI (link)
- AWS Java SDK (link)
- AWS Python SDK (link)

This Week’s Deadlines

- **Quiz 3 (OLI Modules 5 & 6)**
  - Due on **Friday**, Feb 9th, 2018, 11:59PM ET

- **Project 2.1**
  - Due on **Sunday**, Feb 11th, 2018, 11:59PM ET

Questions?