

Final Project Report On iCare Health Service on Cloud

CSYE 6225
Network Structures and Cloud Computing

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1. Introduction

- Cloud computing is a general term used to refer to the delivery of hosted services over the internet.
- Cloud computing enables companies to consume a compute resource, such as a virtual machine (VM), storage or an application, as a utility -- just like electricity – without having to build and maintain computing infrastructures in-house.
- Cloud computing boasts several attractive benefits for businesses and end users. Three of the main benefits of cloud computing are:
- Self-Service Provisioning: End users can spin up compute resources for almost any type of workload on demand. This eliminates the traditional need for IT administrators to provision and manage compute resources.
- Elasticity: Companies can scale up as computing needs increase and scale down again as demands decrease. This eliminates the need for massive investments in local infrastructure which may or may not remain active.
- Pay per use: Compute resources are measured at a granular level, allowing users to pay only for the resources and workloads they use.

2. Requirements

- Develop a login portal using Java Spring MVC which will consist of use-case buttons to simulate an increasing load on the application and database.
- The database can either be a relational database or a NoSQL database.
- The entire stack must be deployed in AWS or Azure.
- Proper infrastructure alerts and triggers to allow for auto-scaling of resources to accommodate the additional load in application, network, data storage and usage with your environment.
- Minimum of one load balancer is required.
- There are 5 use-case buttons that need to be implemented which are follows:
 - Simulation of 3 users log in to application and run 2 report going back 10 days
 - Simulation of 10 users log in to application and run 6 report going back 30 days
 - Simulation of 17 users log in to application and run 10 report going back 60 days
 - Simulation of 24 users log in to application and run 14 report going back 90 days.
 - User input fields to allow me the ability to enter parameters for how many users log in simulation and how many reports those users are uniquely being running.

3. Business Justification

We should deploy a spring/web application on the cloud (Azure / AWS) and the backend database should be an RDS database. Deploying the application in the cloud with the help of an appropriate load balancer and an Auto-scaling scheme should take care of the automatic scaling up and down of the server and should also avoid latency and bottleneck issues.

4. Systems and Descriptions

- a. Techniques Used:
 - Load Balancing
 - Auto Scaling
 - Cloud Watch Monitoring
- b. Platform:
 - Amazon Web Services

c. Web Application

We have a spring MVC application and are using MySQL with RDS as Database.

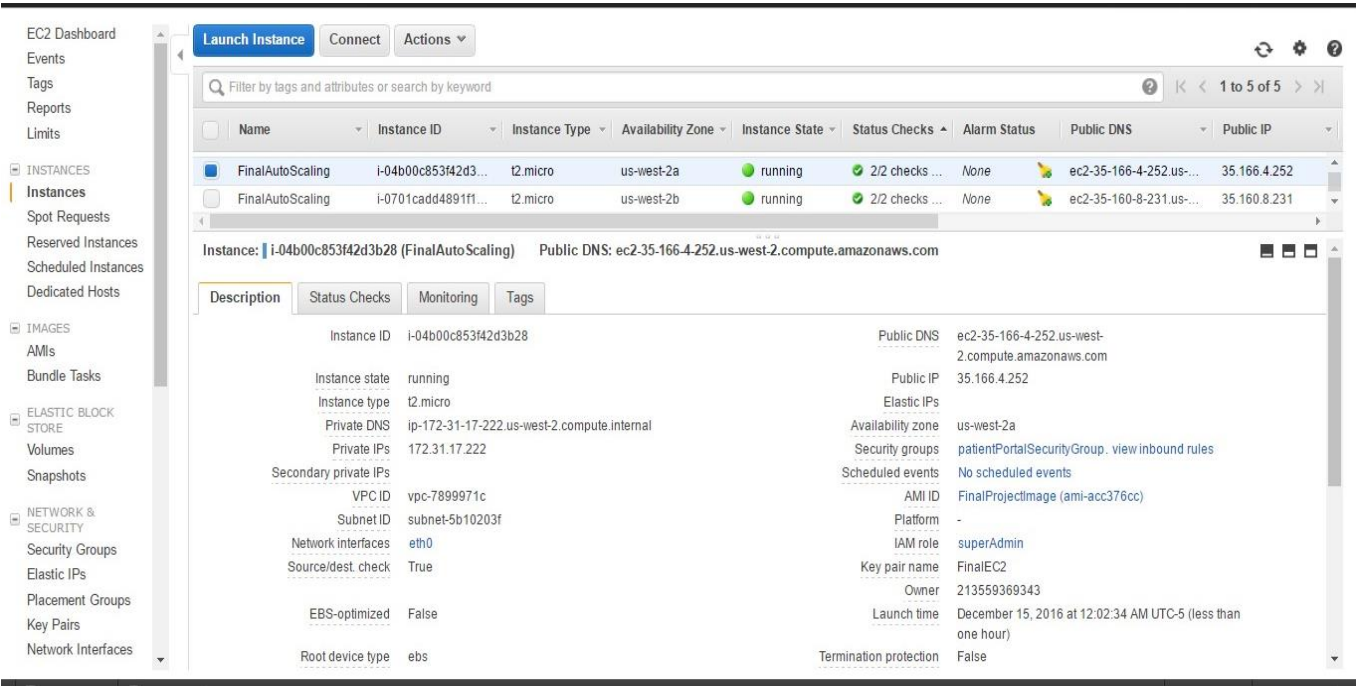
- We have picked a sample dataset from the following URL:
<https://www.healthdata.gov/search/type/dataset>
- The size of this dataset is 5MB and it has nearly 10000 records in the dataset table which contains predominantly patient health related information, which is solely used for report generation. The application has an authentication mechanism and allows users to generate load on the system. The application internally invokes bash script which in turn calls python script to retrieve the records as per use cases.

d. Login Simulation

- We use a python script to trigger user login simulation. The python script is programmed to trigger at the click of use case buttons in the Web application.
- The various use case buttons are preprogrammed with a set value to simulate the logging in of n number of users.
- The python script is triggered using a bash script on AWS.
- Once the python script starts to run, n number of users log in to the web application and try to fetch data from the database which creates a load on the EC2 instance which triggers load balancing and auto scaling.
- The activity on AWS can be observed using Cloud Watch.

e. Launching an instance using private AMI

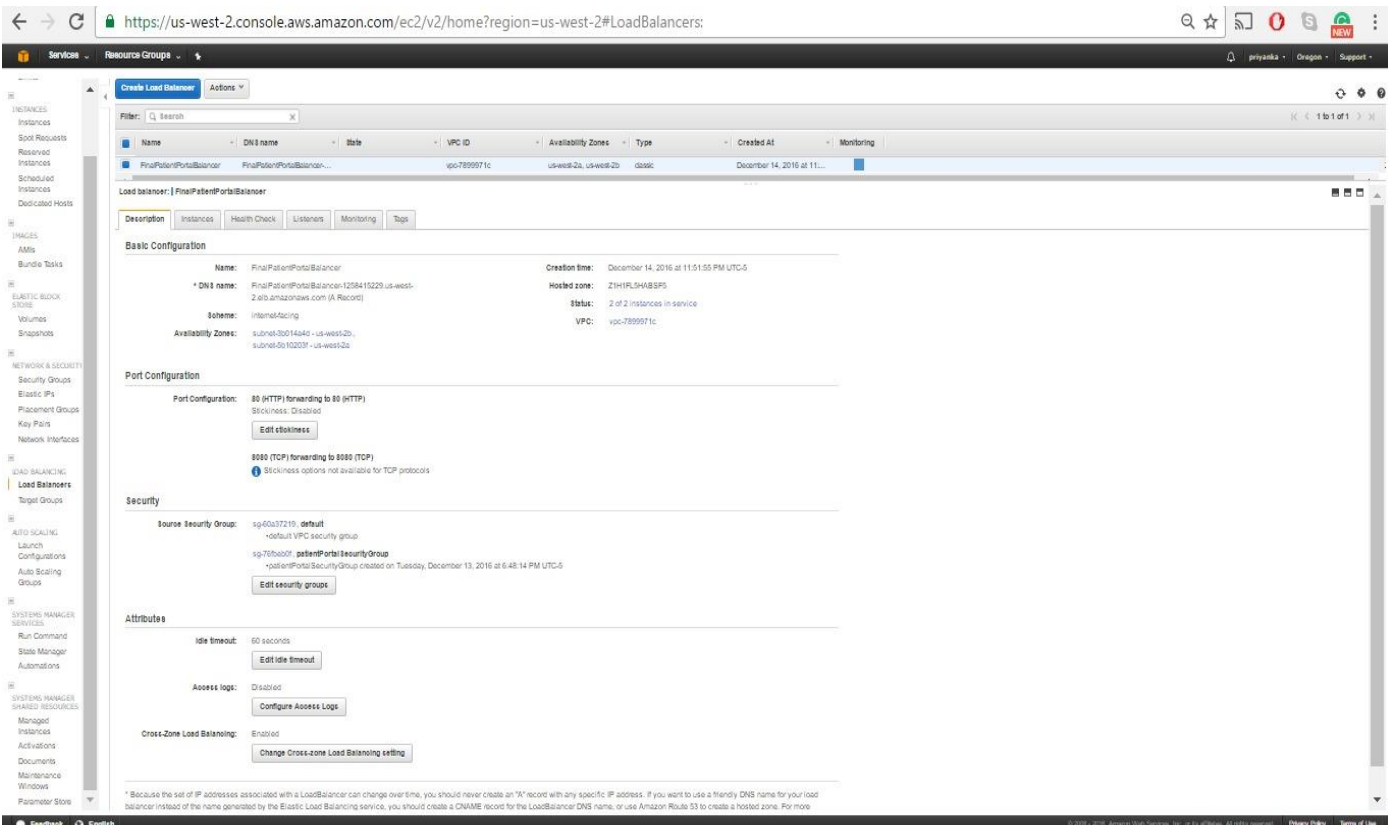
- An AMI contains the information required to create a new instance. For example, an AMI consists of required platform being configured: Apache Tomcat 7, mySQL, python 2.7 and Spring MVC web application. On choosing the private AMI and providing the necessary security groups and to remain eligible for the free tier, we chose the t2.micro instance type. Now the instance is created.



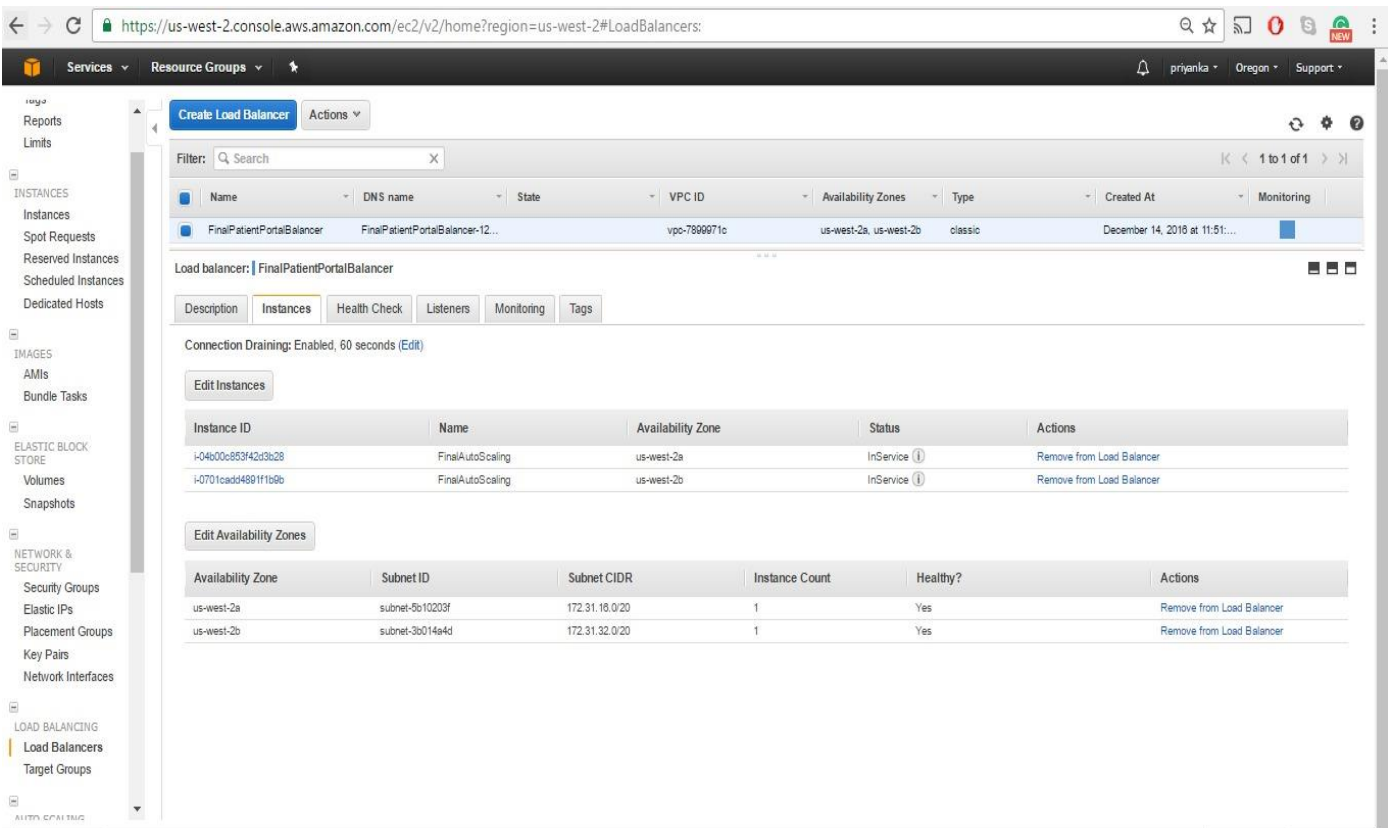
f. Creating Load balancer to listen on http:

- What is load balancing? Load balancing distributes workloads across multiple computing resources, such as computers, a computer cluster, network links, central processing units or disk drives. Load balancing aims to optimize resource use, maximize throughput, minimize response time, and avoid overload of any single resource. We Click Add Listener to create a new listener for the ELB.
- LB Protocol: We Select 'HTTP'
- LB Port: Enter '8080'
- Instance Protocol: Select 'HTTP'

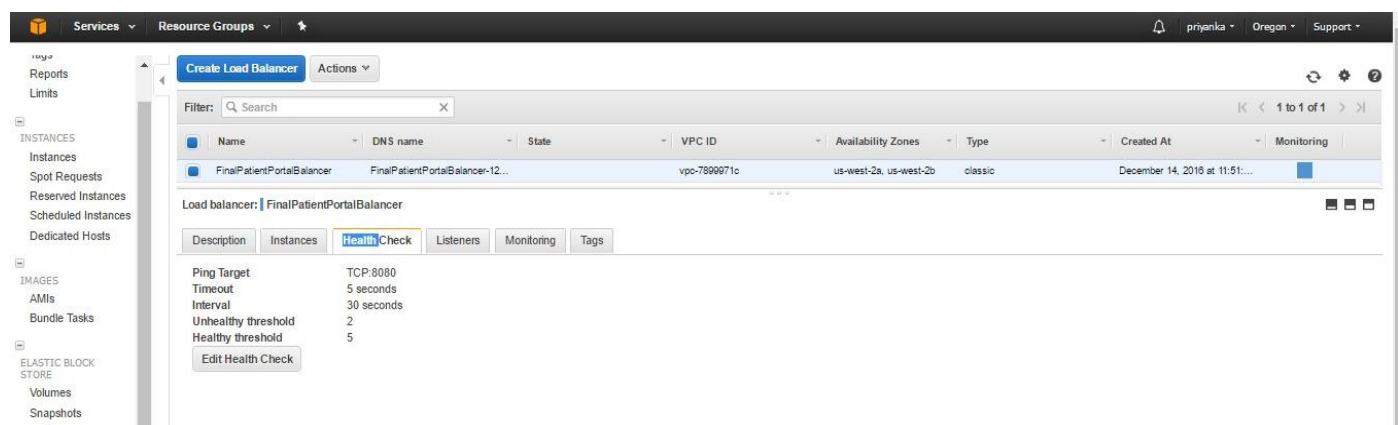
Load Balancer Basic Overview



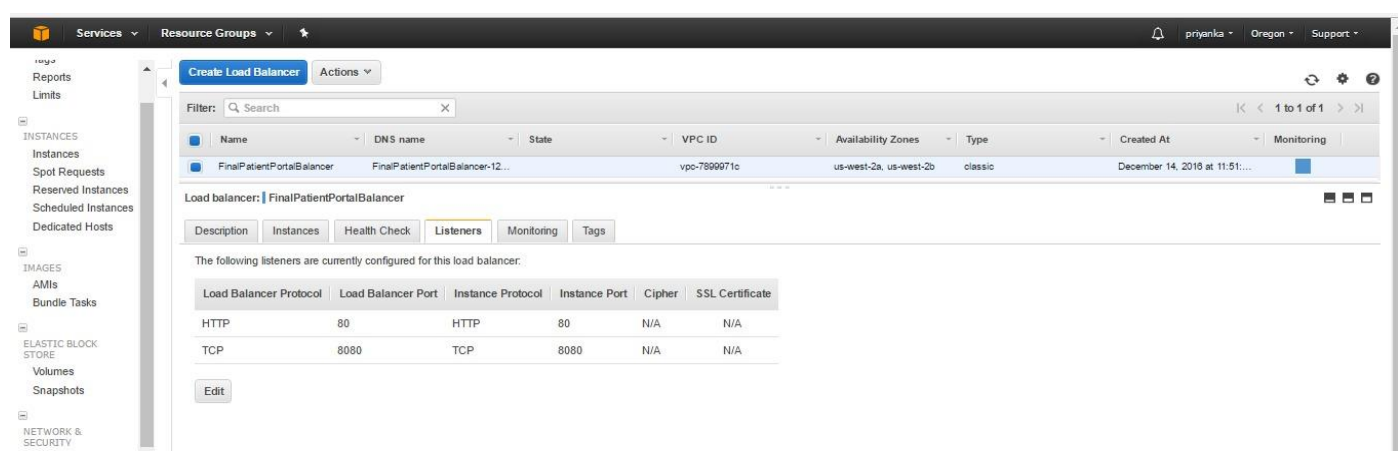
Load Balancer Instance Details



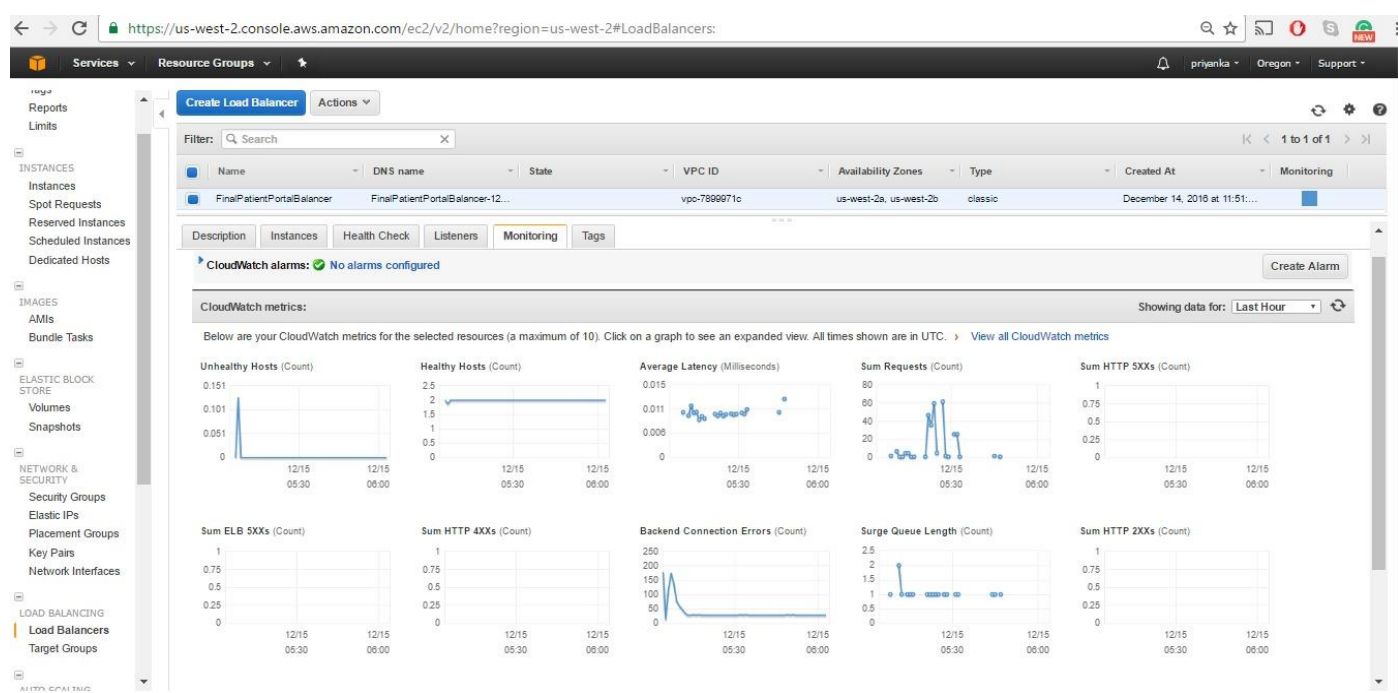
Load Balancer Health Details



Load Balancer Listeners



Load Balancer Monitoring



g. Amazon RDS:

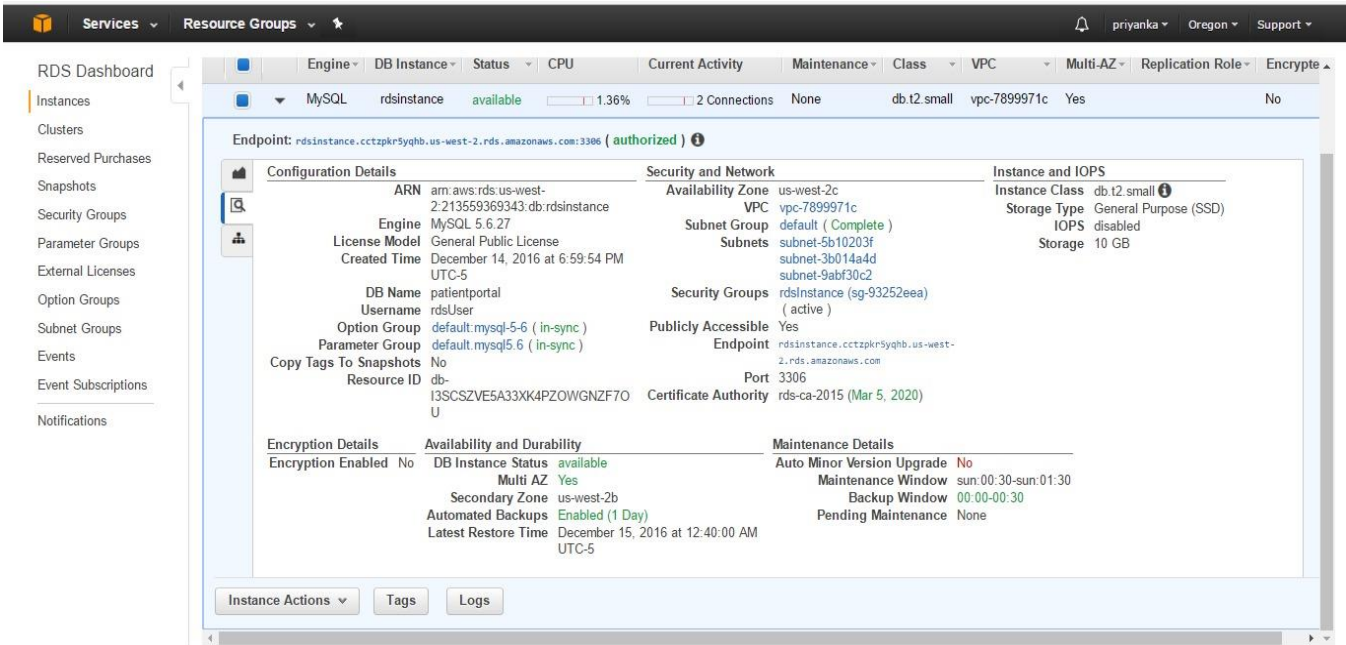
- We have chosen MySQL database engine for RDS.
Mainly for 4 reasons.
- Scalability and Flexibility
 - High Performance
 - High availability
 - Automatic backups and maintenance Amazon RDS for MySQL gives access to the capabilities of a familiar MySQL database engine.

- Creating a DB Instance:

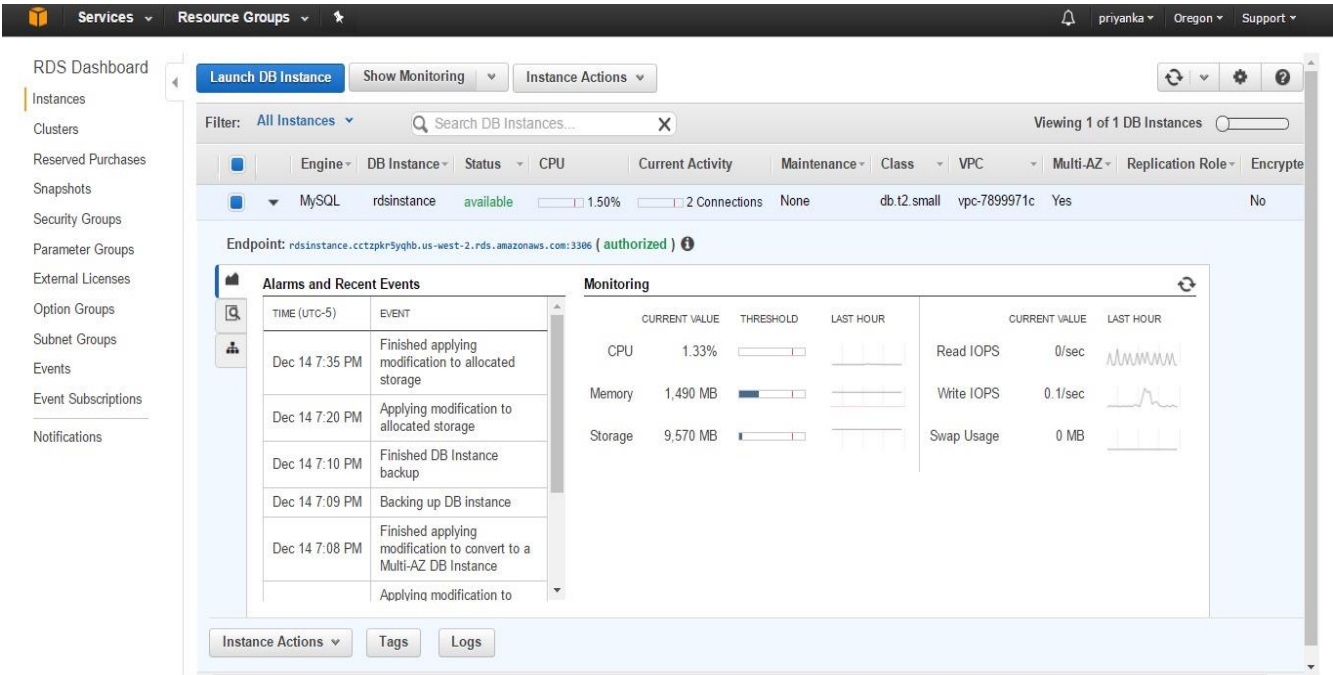
First we create a DB instance. On the Specify DB Details page, specify your DB instance information that includes License model, Db Engine version, DB instance class and DB instance identifier. Then on the Configured Advanced setting page we provide additional information that includes VPC, Subnets and Security groups.

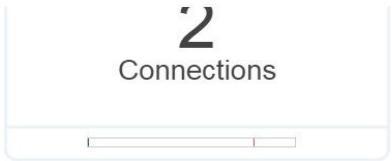
- RDS Connection with Workbench:

We connect the database instance of RDS with MYSQL Workbench. We specify the endpoint of the DB instance with the username and password that was given during the launching of the DB instance.

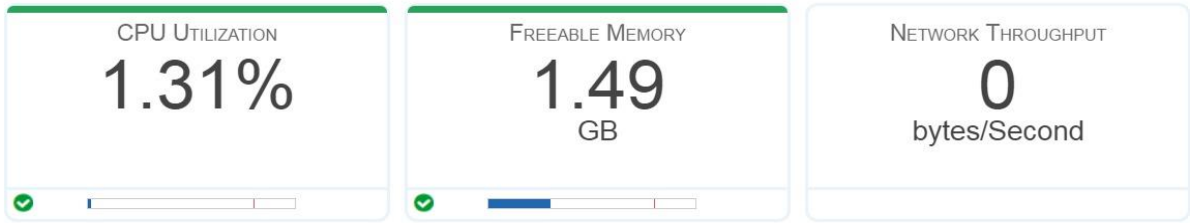


RDS Utilization, Alarms and Recent Events:

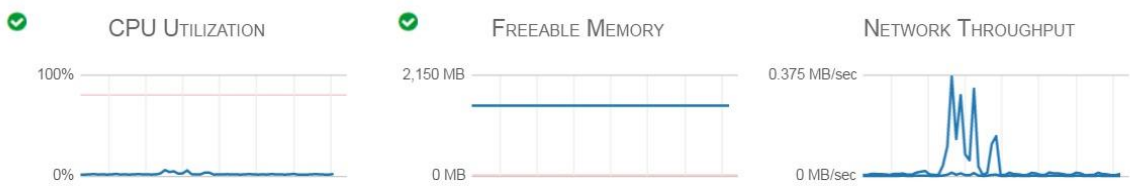




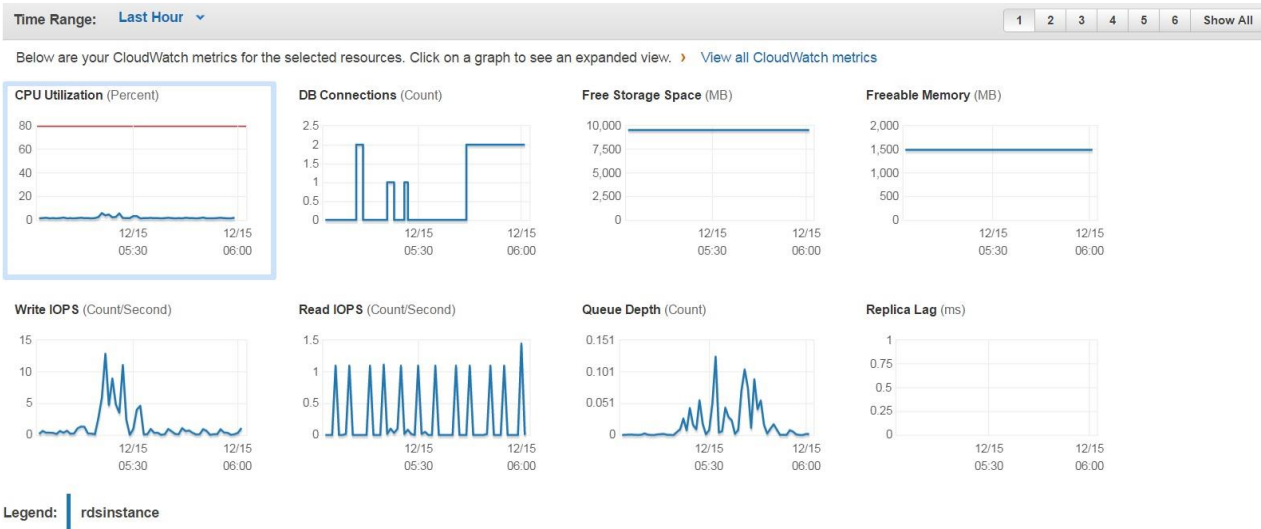
System



System



Complete Graph of all monitoring metrics:

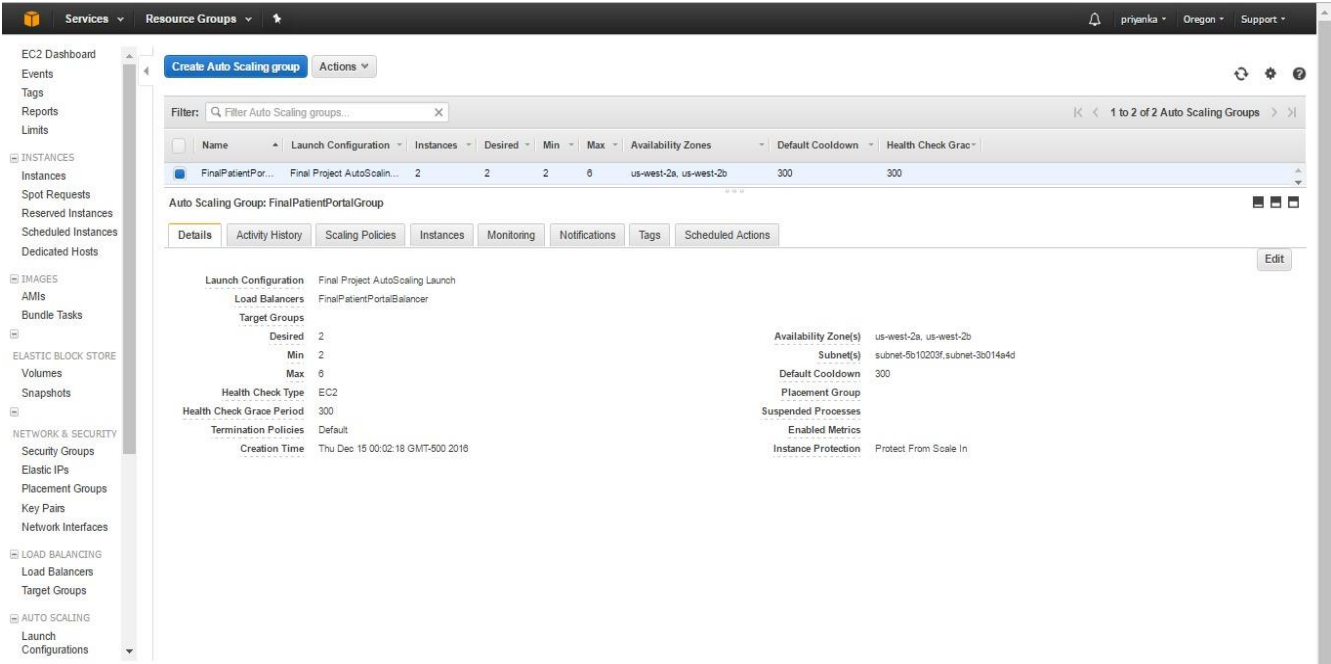


h. Auto Scaling Group:

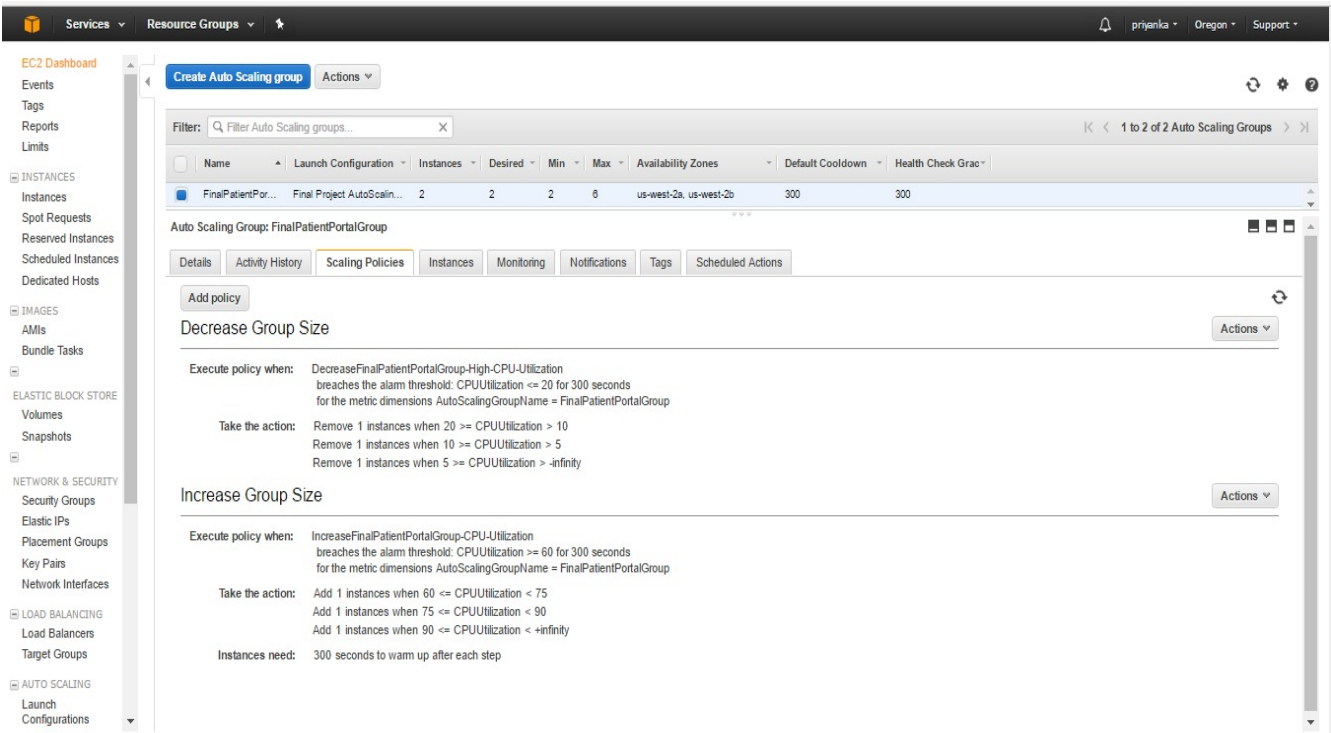
What is Auto Scaling?
Auto-scaling is a cloud computing service feature that automatically adds or removes compute resources (instances) depending on actual usage demands.

- How it works?
- Define an AMI instance and create an Auto Scaling Group to launch instances into.
 - Use Cloud Watch to monitor our server(s)/instance(s), and when certain events happen (i.e. events that can trigger an alarm like CPU utilization or DiskWriteOps)
 - Launch/Decrease instances based on the AMI template we define while creating the auto scaling group. The EC2 instances launch behind the Elastic Load Balancer (ELB) we define. The ELB will send traffic in a round-robin pattern between all the instances assigned to it, and we can control in real time how many instances we want to launch to cover traffic (high and low). If any of the EC2 instances fails to respond, the ELB will detect it and launch a replacement. When web traffic dies down, instances can be terminated automatically.

Auto Scaling Group Details



Auto Scaling Group – Scaling Policies:



Scaling Policies

Step Scaling Policies:

Step Scaling Policy has been set for scaling the instances based on a group of steps. Below are the policy details.

Step 1:

60% <= CPU Utilization <= 75%

The alarm is breached when the threshold of CPU Utilization crosses 60%, a new instance is launched.

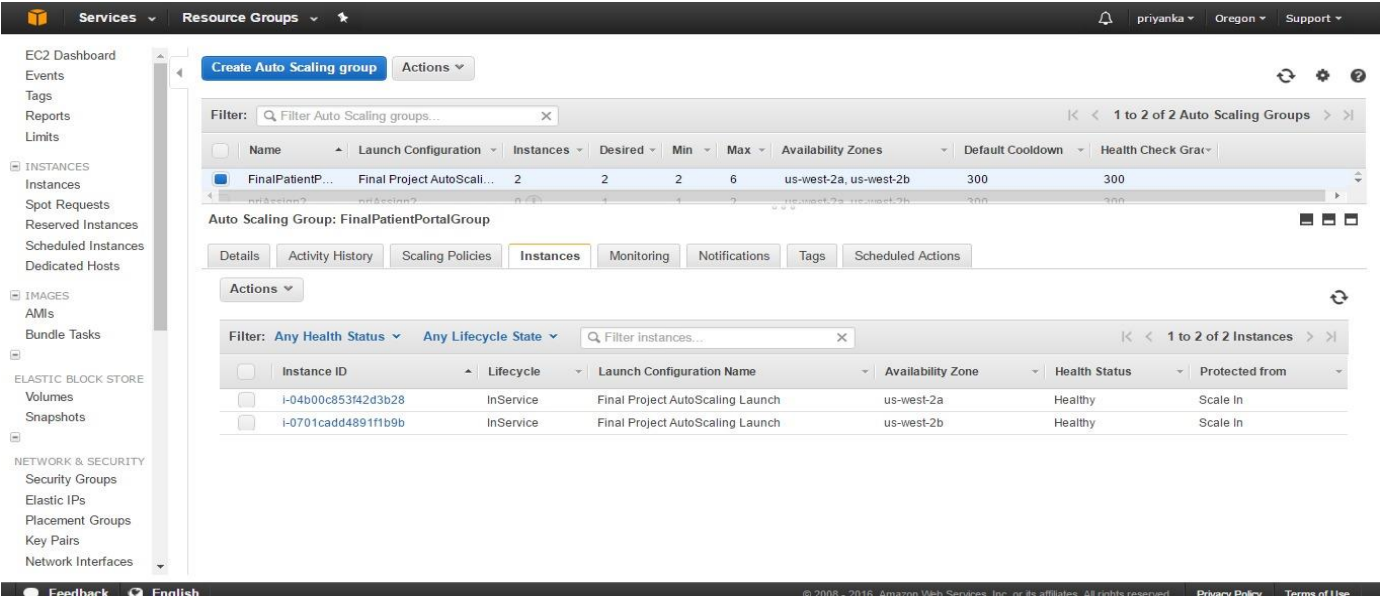
Step 2:

75%<= CPU Utilization <= 90%

The second step adjustment of the scale out policy triggers a new instance when the CPU Utilization crosses 75%.

Step 3
90%<=CPU Utilization <=INFINITY
Similarly, scale out takes place when the specified threshold is breached.

Auto Scaling Group – Health/Instances



Details	Activity History	Scaling Policies	Instances	Monitoring	Notifications	Tags	Scheduled Actions
Filter: Any Status Filter scaling history... 1 to 7 of 7 History Items							
Status	Description	Start Time	End Time				
Successful	Terminating EC2 instance: i-0e529dad676c85052	2016 December 15 11:36:09 UTC-5	2016 December 15 11:37:36 UTC-5				
Successful	Launching a new EC2 instance: i-0e529dad676c85052	2016 December 15 11:34:39 UTC-5	2016 December 15 11:35:31 UTC-5				
Successful	Launching a new EC2 instance: i-0ab3b352e5416e728	2016 December 15 11:32:38 UTC-5	2016 December 15 11:33:30 UTC-5				
Cancelled	Could not scale to desired capacity because all re...	2016 December 15 11:31:06 UTC-5	2016 December 15 11:31:06 UTC-5				
Successful	Launching a new EC2 instance: i-0d02cd898e53bdd39	2016 December 15 11:29:36 UTC-5	2016 December 15 11:30:29 UTC-5				
Successful	Launching a new EC2 instance: i-09397e00a25ad294b	2016 December 15 11:11:00 UTC-5	2016 December 15 11:11:48 UTC-5				
Successful	Launching a new EC2 instance: i-08cb559c8e38ac16c	2016 December 15 11:11:00 UTC-5	2016 December 15 11:11:33 UTC-5				

i. Cloud Watch

Cloud watch enables real time monitoring of AWS resources such as Amazon EC2 instances, Load Balancers and Amazon RDS database instances. Cloud watch collects and processes raw data into real-time metrics.

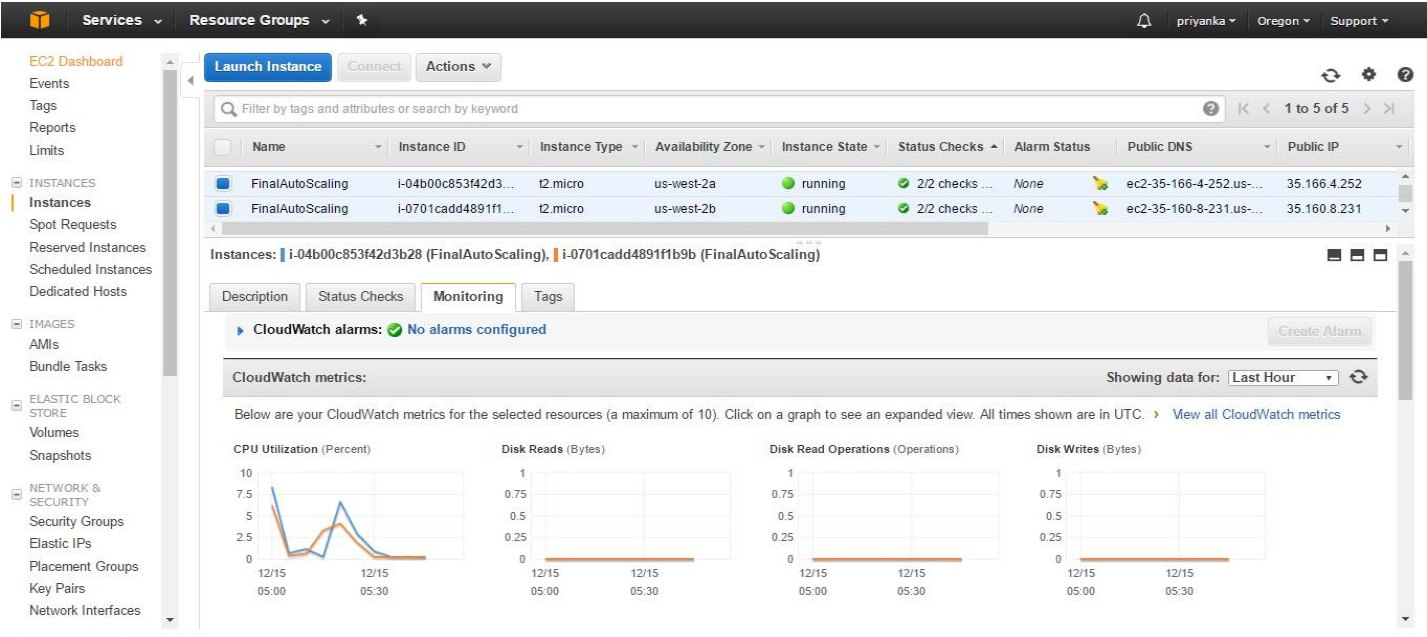
Cloud watch works with the help of alarms. An alarm can have three possible states.

- OK—The metric is within the defined threshold
- ALARM—The metric is outside of the defined threshold
- INSUFFICIENT_DATA—The alarm has just started, the metric is not available, or not enough data is available for the metric to determine the alarm state.

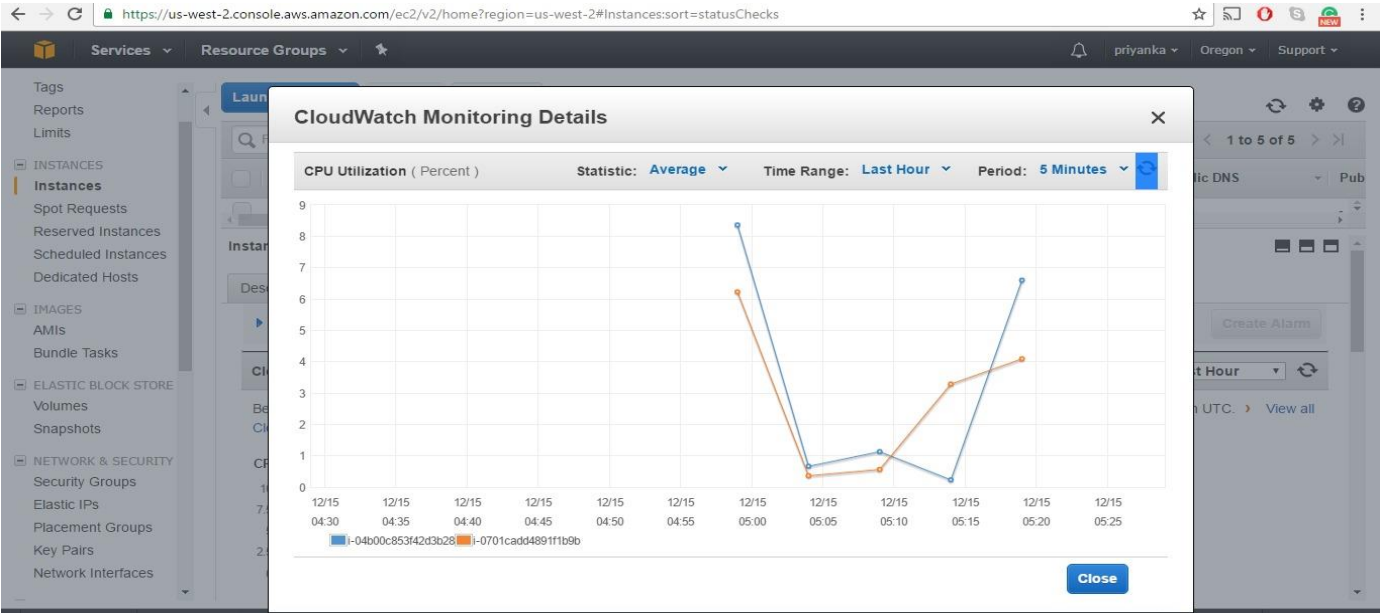
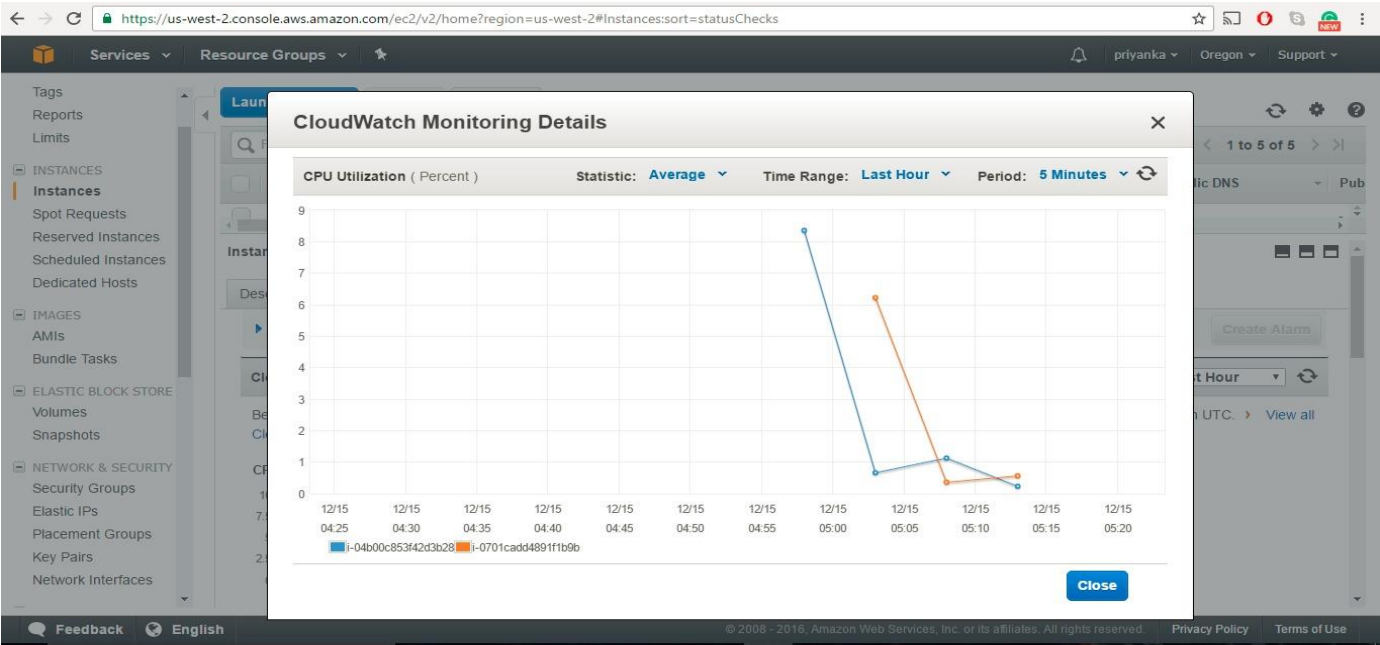
For our application, we have set 2 alarms to trigger. We have chosen the CPU utilization metrics from EC2.

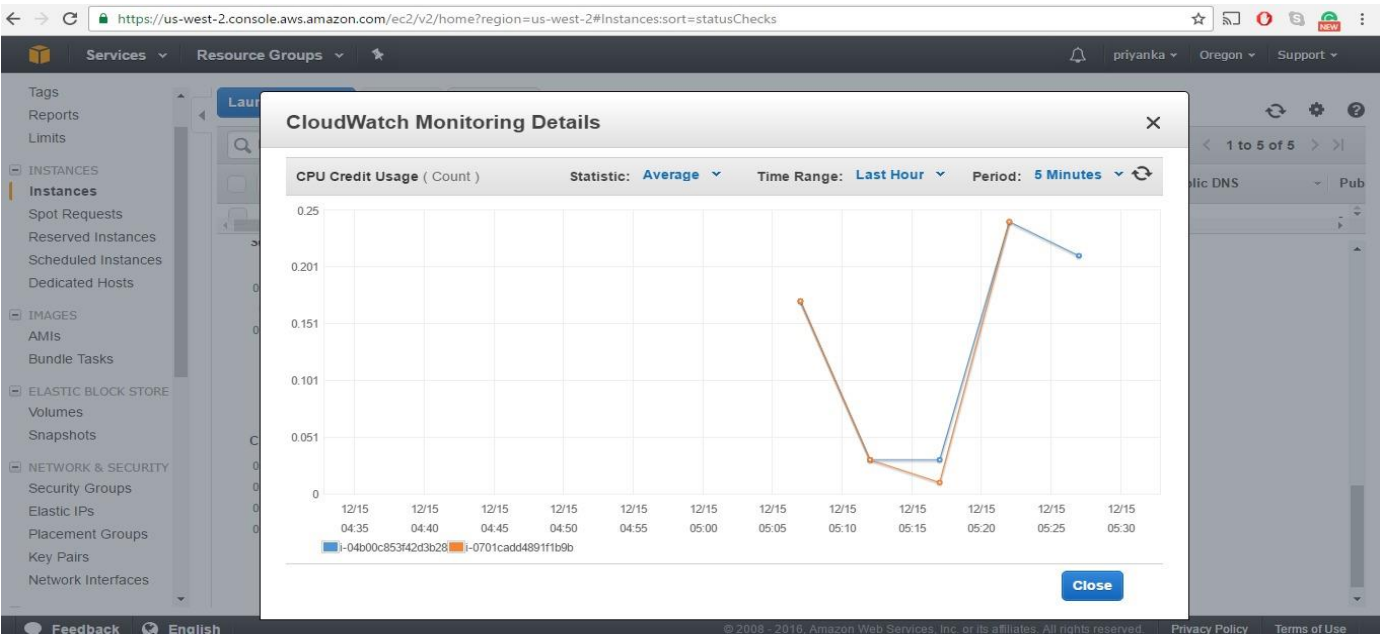
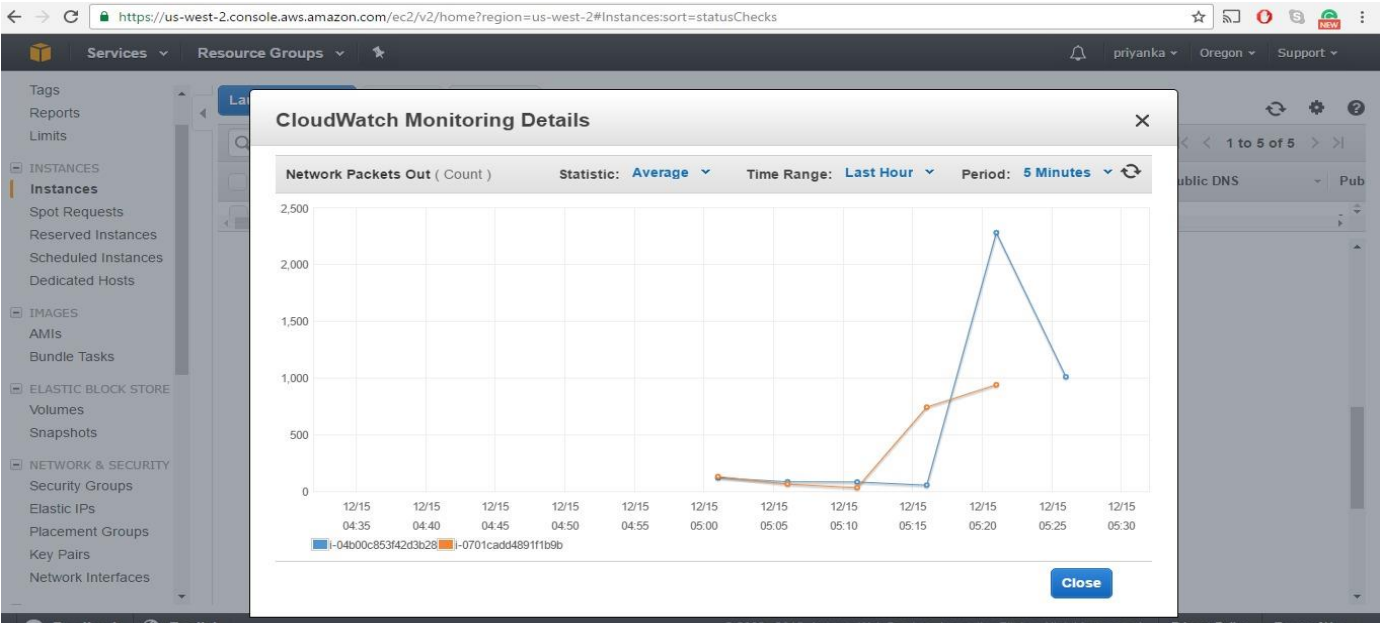
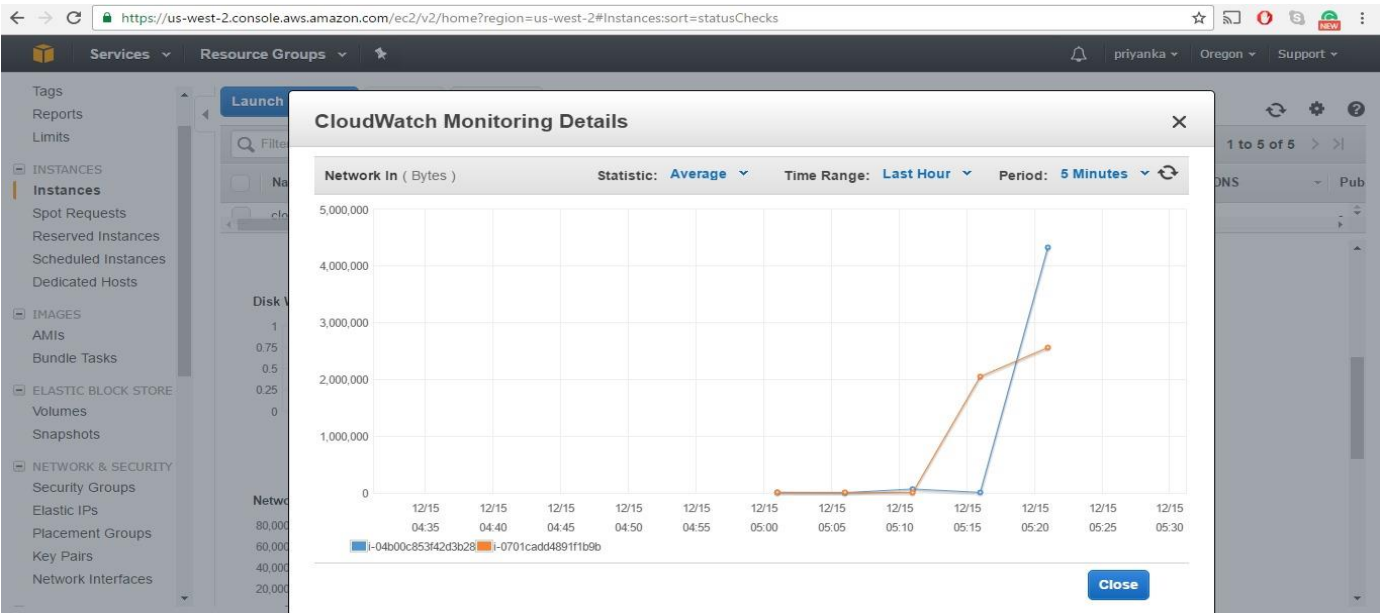
1. If the CPU utilization is > 60% for 5 mins then the auto scaling group will automatically scale up by an instance.
2. If the CPU utilization is <5% for 5 mins then the auto scaling group will automatically scale down by one instance.

Below is the Cloud Watch Monitoring Tab of the Load Balancers

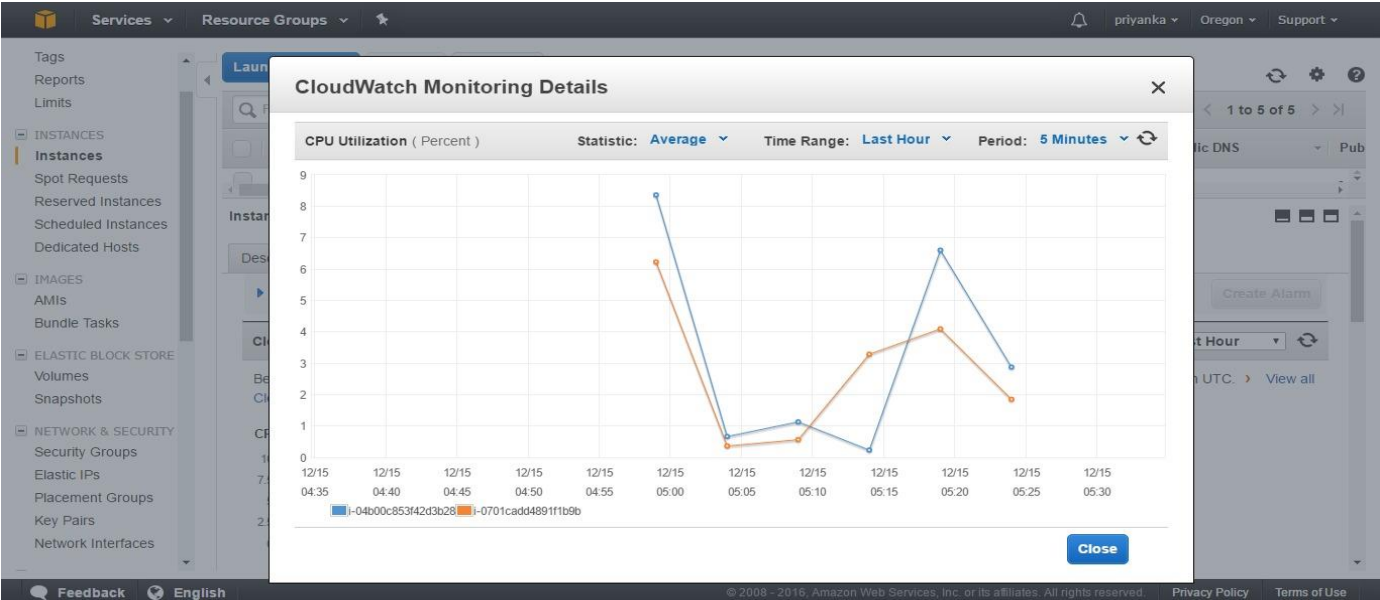


Cloud Watch Monitoring Screenshots





CPU Utilization Final Monitoring



3. Cloud Pricing model for the next 3-6 months

Services

Estimate of your Monthly Bill (\$ 80.41)

Estimate of Your Monthly Bill

☒ Show First Month's Bill (include all one-time fees, if any)

Below you will see an estimate of your monthly bill. Expand each line item to see cost breakout of each service. To save this bill and input values, click on 'Save and Share' button. To remove the service from the estimate, jump back to the service and clear the specific service's form.

Save and Share

<input type="checkbox"/> Amazon EC2 Service (US-East)		\$	56.46
Compute:	\$	38.08	
Elastic LBs:	\$	18.30	
Data Processed by Elastic LBs:	\$	0.08	
<input type="checkbox"/> Amazon RDS Service (US-East)		\$	53.03
<input type="checkbox"/> Amazon CloudWatch Service (US-East)		\$	0.00
<input type="checkbox"/> AWS Support (Basic)		\$	0.00
Free Tier Discount:		\$	-29.08
Total Monthly Payment:		\$	80.41

Individual Components' Pricing

EC2

Services

Estimate of your Monthly Bill (\$ 80.41)

Choose region: US-East / US Standard (Virginia)

Inbound Data Transfer is Free and Outbound Data Transfer is 1 GB free per region per month

Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale computing easier for developers. Amazon Elastic Block Store (EBS) provides persistent storage to Amazon EC2 instances.

Clear Form

Compute: Amazon EC2 Instances:

Description	Instances	Usage	Type	Billing Option	Monthly Cost
<div><div>−</div>EC2 instances</div>	2	100 % Utilized/h	Linux on t2.micro	<div><div>⚙</div>On-Demand (No Cor<div>⚙</div></div>	\$ 19.04
<div><div>−</div>EC2 instances</div>	4	50 % Utilized/h	Linux on t2.micro	<div><div>⚙</div>On-Demand (No Cor<div>⚙</div></div>	\$ 19.04
<div><div>⊕</div>Add New Row</div>					

Compute: Amazon EC2 Dedicated Hosts:

Description	Number of Hosts	Usage	Type	Billing Option
<div><div>⊕</div>Add New Row</div>				

Storage: Amazon EBS Volumes:

Description	Volumes	Volume Type	Storage	IOPS	Baseline Throughput	Snapshot Storage
<div><div>⊕</div>Add New Row</div>						

Services

Estimate of your Monthly Bill (\$ 80.41)

Choose region:

US-East / US Standard (Virginia)

Inbound Data Transfer is Free and Outbound Data Transfer is 1 GB free per region per month

Amazon RDS is a web service that makes it easier to set up, operate, and scale a relational database in the cloud. Cost calculation for Amazon Aurora is coming soon. Please check the pricing page for Amazon Aurora pricing details.

Clear Form

Amazon RDS On-Demand DB Instances:

Description	DB Instances	Usage	DB Engine and License	Class and Deployment	Storage	I/O
<div><div></div><div>RDS Instance</div></div>	<div>1</div>	<div>100</div> <div>% Utilized/1h</div>	<div>MySQL</div>	<div>db.t2.small</div> <div>Multi-AZ</div>	<div>General P</div> <div>10 GB</div>	<div>Provisioned IOPS:</div> <div>0</div>
<div><div></div><div>Add New Row</div></div>						

Additional Backup Storage (Free backup storage up to 100% of provisioned Storage):

Backup Type	Backup Storage
<div><div></div><div>Standard Backup</div></div>	<div>10 GB-month of Storage</div>
<div><div></div><div>Add New Row</div></div>	

Amazon RDS Reserved DB Instances:

Description	DB Instances	Usage	DB Engine and License	Class and Deployment	Offering and Term	Storage	I/O
<div><div></div><div>Add New Row</div></div>							

Cloud Watch

Services

Estimate of your Monthly Bill (\$ 80.41)

Choose region:

US-East / US Standard (Virginia)

Amazon CloudWatch is a web service that enables you to monitor your Amazon EC2 instances, Amazon EBS volumes, Elastic Load Balancers, and Amazon RDS database instances in real-time. You can also supply your own custom application metrics. With Amazon CloudWatch you can access up-to-the-minute statistics, view graphs, and set alarms for your metric data.

Clear Form

FREE TIER: Each month, new and existing Amazon CloudWatch customers receive 10 metrics (applicable to Detailed Monitoring for Amazon EC2 instances or Custom Metrics), 10 alarms, and 1 million API requests each month at no additional charge.

Custom Metrics:

Description	AWS Resources	Custom metrics per resource	Frequency of metrics data	Alarms per resource	Ingested Logs Size (GB)	Archived Logs Size (GB)
<div><div></div><div>RDS</div></div>	<div>1</div>	<div>0</div>	<div>at 5-min intervals</div>	<div>2</div>	<div>0</div>	<div>0</div>
<div><div></div><div>EC2</div></div>	<div>1</div>	<div>0</div>	<div>at 5-min intervals</div>	<div>2</div>	<div>0</div>	<div>0</div>
<div><div></div><div>Add New Row</div></div>						

Alarms For:

EC2 Instances*:

0 Alarms

Elastic Load Balancers:

0 Alarms

EBS Volumes:

0 Alarms

RDS DB Instances:

2 Alarms

Auto Scaling Service:

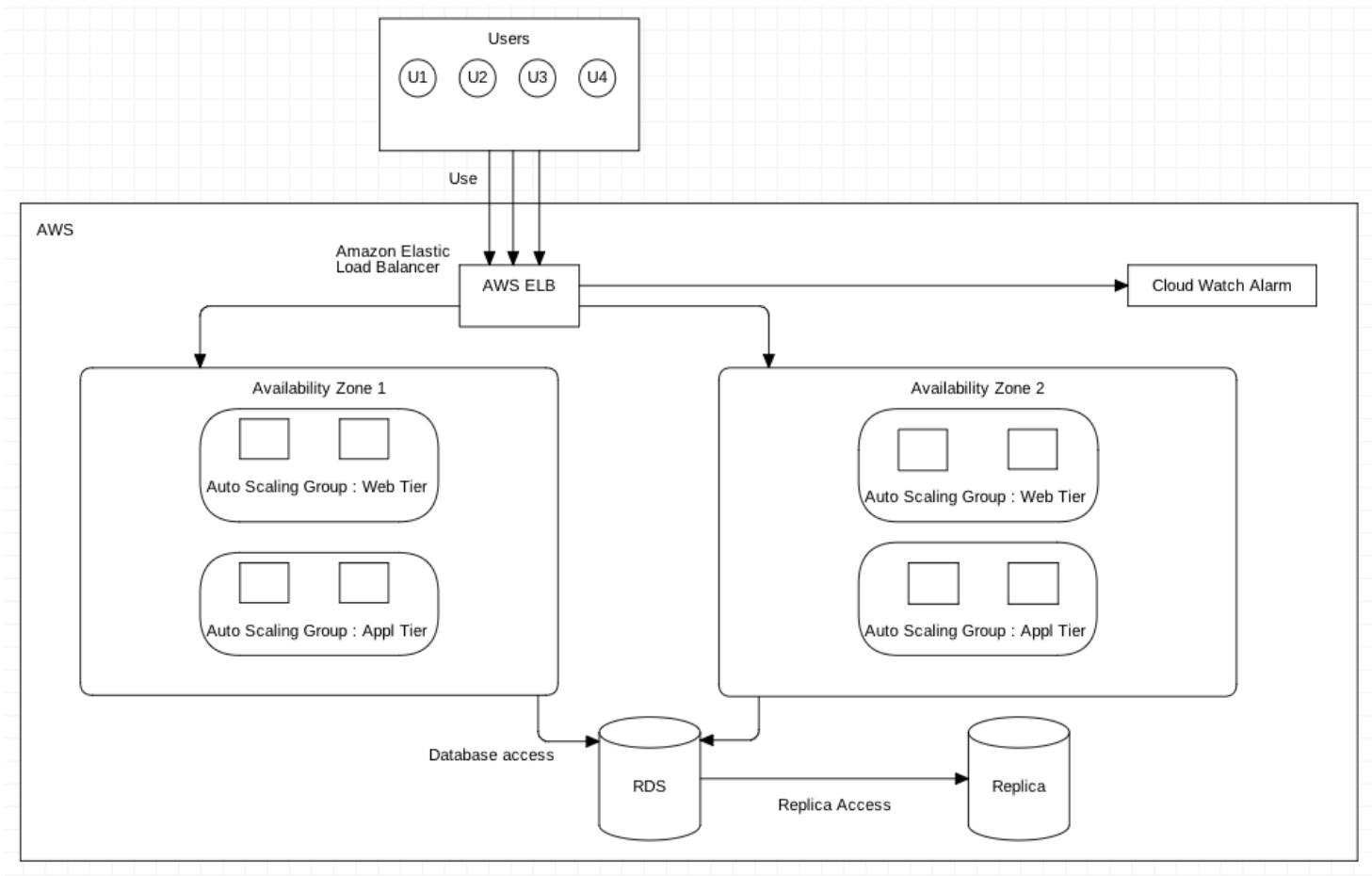
2 Alarms

5. Disaster Recovery Procedures

- a. Pilot Light Model for Quick Recovery
- The term pilot light is often used to describe a DR scenario in which a minimal version of an environment is always running on the cloud. Our infrastructure has been built on Amazon RDS which allows for having a master and redundant read replica which is on standby. To provision the remainder of the infrastructure to restore business-critical services, we have preconfigured servers bundled as AMI’s (Amazon Machine Images), which are ready to be started up at a moment’s notice. When starting recovery, instances from these AMIs come up quickly with their pre-defined role (for example, Web Server or App Server) within the deployment around the pilot light model. We are using ELB (Elastic Load Balancing) to distribute traffic to multiple instances. Our clients interact with the application through the load balancer, so that any instances going down or coming up wouldn't have any impact for them.
- b. Preparation Phase
- We are using RDS to have a read replica of the Database, since the Database is small we have the replica of the entire Database. Any changes to the operating system, application and scripts are periodically updated and stored as an AMI, all our instances are launched from this AMI instance. We monitor the health of these instances through Cloud Watch to check their status
- c. Recovery Phase
- To recover the remainder of the environment around the pilot light model, we start our systems from the AMIs within minutes on the appropriate instance types. We also make sure that we have at least two instances running at any time and both of them on different subnets. After recovery we again ensure that the redundancy is restored in RDS

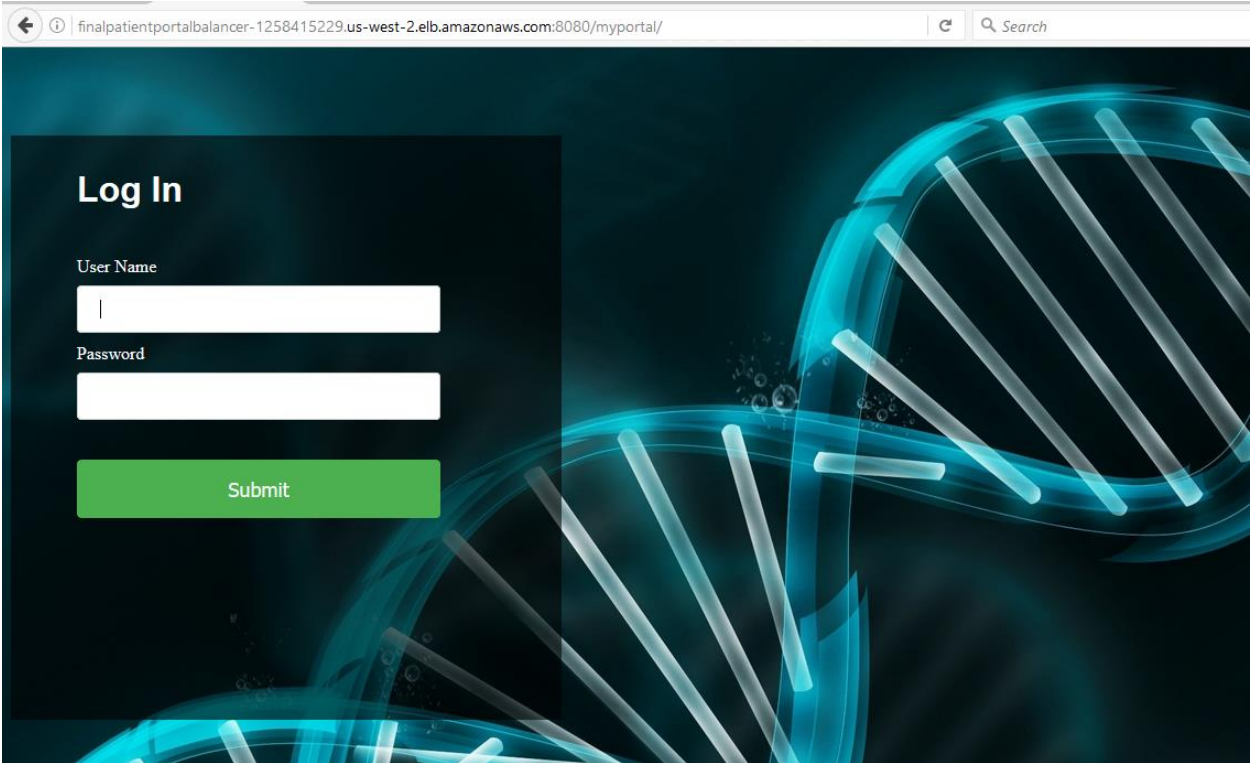
Also we use auto scaling policies to handle traffic by launching more instances and scaling out our architecture

Visio Diagram of the Architecture



6. Application Screenshots

Login page



finalpatientportalbalancer-1258415229.us-west-2.elb.amazonaws.com:8080/myportal/loginUser.htm

Search

☆📁⬇️🏠

Use Case 1Use Case 2Use Case 3Use Case 4Use Case 5

Output: After running the scripts

Use Case Execution

session open for
user1
2 FEMALE 67 Negative Negative T4 N4 Positive M2 Positive No_Conversion 03/01/15 0:00
2 FEMALE 91 Negative Negative T28 N28 Positive M26 Positive No_Conversion 03/02/15 0:00
2 FEMALE 115 Negative Negative T52 N52 Positive M50 Positive No_Conversion 03/03/15 0:00
2 FEMALE 139 Negative Negative T76 N76 Positive M74 Positive No_Conversion 03/04/15 0:00
2 FEMALE 163 Negative Negative T100 N100 Positive M98 Positive No_Conversion 03/05/15 0:00
2 FEMALE 187 Negative Negative T124 N124 Positive M122 Positive No_Conversion 03/06/15 0:00
2 FEMALE 211 Negative Negative T148 N148 Positive M146 Positive No_Conversion 03/07/15 0:00
2 FEMALE 235 Negative Negative T172 N172 Positive M170 Positive No_Conversion 03/08/15 0:00
2 FEMALE 259 Negative Negative T196 N196 Positive M194 Positive No_Conversion 03/09/15 0:00
2 FEMALE 283 Negative Negative T220 N220 Positive M218 Positive No_Conversion 03/10/15 0:00
2 FEMALE 307 Negative Negative T244 N244 Positive M242 Positive No_Conversion 03/11/15 0:00
2 FEMALE 331 Negative Negative T268 N268 Positive M266 Positive No_Conversion 03/12/15 0:00
2 FEMALE 355 Negative Negative T292 N292 Positive M290 Positive No_Conversion 03/13/15 0:00
2 FEMALE 379 Negative Negative T316 N316 Positive M314 Positive No_Conversion 03/14/15 0:00
2 FEMALE 403 Negative Negative T340 N340 Positive M338 Positive No_Conversion 03/15/15 0:00
2 FEMALE 427 Negative Negative T364 N364 Positive M362 Positive No_Conversion 03/16/15 0:00
2 FEMALE 451 Negative Negative T388 N388 Positive M386 Positive No_Conversion 03/17/15 0:00
2 FEMALE 475 Negative Negative T412 N412 Positive M410 Positive No_Conversion 03/18/15 0:00
2 FEMALE 499 Negative Negative T436 N436 Positive M434 Positive No_Conversion 03/19/15 0:00

Output: After running the scripts

session open for
user2
3 FEMALE 68 Negative Negative T5 N5 Positive M3 Positive No_Conversion 03/01/15 0:00
3 FEMALE 92 Negative Negative T29 N29 Positive M27 Positive No_Conversion 03/02/15 0:00
3 FEMALE 116 Negative Negative T53 N53 Positive M51 Positive No_Conversion 03/03/15 0:00
3 FEMALE 140 Negative Negative T77 N77 Positive M75 Positive No_Conversion 03/04/15 0:00
3 FEMALE 164 Negative Negative T101 N101 Positive M99 Positive No_Conversion 03/05/15 0:00
3 FEMALE 188 Negative Negative T125 N125 Positive M123 Positive No_Conversion 03/06/15 0:00
3 FEMALE 212 Negative Negative T149 N149 Positive M147 Positive No_Conversion 03/07/15 0:00
3 FEMALE 236 Negative Negative T173 N173 Positive M171 Positive No_Conversion 03/08/15 0:00
3 FEMALE 260 Negative Negative T197 N197 Positive M195 Positive No_Conversion 03/09/15 0:00
3 FEMALE 284 Negative Negative T221 N221 Positive M219 Positive No_Conversion 03/10/15 0:00
3 FEMALE 308 Negative Negative T245 N245 Positive M243 Positive No_Conversion 03/11/15 0:00
3 FEMALE 332 Negative Negative T269 N269 Positive M267 Positive No_Conversion 03/12/15 0:00
3 FEMALE 356 Negative Negative T293 N293 Positive M291 Positive No_Conversion 03/13/15 0:00
3 FEMALE 380 Negative Negative T317 N317 Positive M315 Positive No_Conversion 03/14/15 0:00
3 FEMALE 404 Negative Negative T341 N341 Positive M339 Positive No_Conversion 03/15/15 0:00
3 FEMALE 428 Negative Negative T365 N365 Positive M363 Positive No_Conversion 03/16/15 0:00
3 FEMALE 452 Negative Negative T389 N389 Positive M387 Positive No_Conversion 03/17/15 0:00
3 FEMALE 476 Negative Negative T413 N413 Positive M411 Positive No_Conversion 03/18/15 0:00
3 FEMALE 500 Negative Negative T437 N437 Positive M435 Positive No_Conversion 03/19/15 0:00
3 FEMALE 68 Negative Negative T5 N5 Positive M3 Positive No_Conversion 03/01/15 0:00
3 FEMALE 92 Negative Negative T29 N29 Positive M27 Positive No_Conversion 03/02/15 0:00
3 FEMALE 116 Negative Negative T53 N53 Positive M51 Positive No_Conversion 03/03/15 0:00

Output: After running the scripts

```
session open for
user3
4 FEMALE 69 Negative Negative T6 N6 Positive M4 Positive No_Conversion 03/01/15 0:00
4 FEMALE 93 Negative Negative T30 N30 Positive M28 Positive No_Conversion 03/02/15 0:00
4 FEMALE 117 Negative Negative T54 N54 Positive M52 Positive No_Conversion 03/03/15 0:00
4 FEMALE 141 Negative Negative T78 N78 Positive M76 Positive No_Conversion 03/04/15 0:00
4 FEMALE 165 Negative Negative T102 N102 Positive M100 Positive No_Conversion 03/05/15 0:00
4 FEMALE 189 Negative Negative T126 N126 Positive M124 Positive No_Conversion 03/06/15 0:00
4 FEMALE 213 Negative Negative T150 N150 Positive M148 Positive No_Conversion 03/07/15 0:00
4 FEMALE 237 Negative Negative T174 N174 Positive M172 Positive No_Conversion 03/08/15 0:00
4 FEMALE 261 Negative Negative T198 N198 Positive M196 Positive No_Conversion 03/09/15 0:00
4 FEMALE 285 Negative Negative T222 N222 Positive M220 Positive No_Conversion 03/10/15 0:00
4 FEMALE 309 Negative Negative T246 N246 Positive M244 Positive No_Conversion 03/11/15 0:00
4 FEMALE 333 Negative Negative T270 N270 Positive M268 Positive No_Conversion 03/12/15 0:00
4 FEMALE 357 Negative Negative T294 N294 Positive M292 Positive No_Conversion 03/13/15 0:00
4 FEMALE 381 Negative Negative T318 N318 Positive M316 Positive No_Conversion 03/14/15 0:00
4 FEMALE 405 Negative Negative T342 N342 Positive M340 Positive No_Conversion 03/15/15 0:00
4 FEMALE 429 Negative Negative T366 N366 Positive M364 Positive No_Conversion 03/16/15 0:00
4 FEMALE 453 Negative Negative T390 N390 Positive M388 Positive No_Conversion 03/17/15 0:00
4 FEMALE 477 Negative Negative T414 N414 Positive M412 Positive No_Conversion 03/18/15 0:00
4 FEMALE 501 Negative Negative T438 N438 Positive M436 Positive No_Conversion 03/19/15 0:00
4 FEMALE 69 Negative Negative T6 N6 Positive M4 Positive No_Conversion 03/01/15 0:00
4 FEMALE 93 Negative Negative T30 N30 Positive M28 Positive No_Conversion 03/02/15 0:00
4 FEMALE 117 Negative Negative T54 N54 Positive M52 Positive No_Conversion 03/03/15 0:00
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7. References:

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