Python for Cloud

Outline

- Python for Amazon Web Services
- Python for Google Cloud
- Python for Windows Azure
- Python for MapReduce
- Python Packages of Interest
- Python Web Application Framework - Django
- Development with Django

AMAZON WEB SERVICES

It provides a hypothetical technical infrastructure with distributed computing building blocks, tools and services
AWS Cloud Platform

- Compute:
  - EC2
  - Light Sail
  - Lambda
  - Elastic Beanstalk
  - EC2 Image Builder
- Storage
  - Amazon S3
  - Amazon Glacier
- Databases
  - RDS
  - DynamoDB
  - ElastiCache
  - Neptune Amazon Redshift
- Networking and Content Delivery
  - VPC
  - CloudFront
  - Route53
  - API Gateway
- Security, Identity and Compliance
  - IAM
  - Cognito
  - GuardDuty
  - Detective

Why AWS?

The reason for choosing AWS is

- Fastest growing cloud computing platform.
- Largest public cloud platform.
- More and more organizations are migrating their IT infrastructure to AWS.
- Five pillars of AWS.

Amazon EC2

- It is a compute service provided by AWS which stands for Amazon Elastic Compute Cloud.
- It is a web service that provides secure, scalable compute capacity in the cloud.
- It provides you with the complete control of your computing resources and lets you run on Amazon's proven computing environment

Boto

- Boto is an interface that integrates the present and future infrastructural services offered by Amazon Web Services (AWS).
- Boto is a Software Development Kit (SDK) which is developed to enhance the use of python in Amazon Web Services.
- It helps Python users to create, configure and manage AWS services
- This SDK was started as a customer-contributed library to help users to build Python based applications in cloud, to convert Application Programming Interface (API) feedback from AWS into Python classes.

Installing Boto

Installing Boto from Github

Steps to Install:

```
$ git clone https://github.com/boto/boto
$ cd boto
$ sudo python setup.py install
```

Installing Boto with pip

```
$ sudo pip install boto
```

GETTING STARTED WITH AWS

Creating AWS account

- http://aws.amazon.com/ and click on the Sign Up Now button

AWS Account Credentials

- It consists of email address and a password.
- These are the credentials you use to log into the AWS web portal and the AWS Management Console

AWS Account Number

- unique 12-digit number associated with your AWS account.
- The Account Number is a public identifier and is mainly used for sharing resources within AWS

Amazon EC2 – Python Example

```
import os
import time
import boto
import boto.manage.cmdshell
def launch_instance (
ami='ami-7341783a’,
instance_type='t1.micro,
key_name='pass’,
key_extension='.pem’,
key_dir='~/.ssh’,
group_name='pass’,
ssh_port=22,
cidr='0.0.0.0/0’,
tag='pass’,
user_data='none’,
cmd_shell='True’,
login_user='ec2-user’,
ssh_passwd=None):
```

AMI: The ID of the Amazon Machine Image
Instance_type: The type of the instance.
Key_name: The name of the SSH key used for logging into the instance
Key_extension: The file extension for SSH private key files.
Key_Dir: The path to the directory containing SSH private key files.
Group_name: The name of the security group used to control access to the instance.
Ssh_port: The port number you want to use for SSH access
Cidr: The CIDR block used to acess from anywhere.
Tag: A name that will be passed to the newly started instance at launch
Cmd_shell: A boto CmdShell object will be created and returned.

Amazon EC2 – Python Example

- Boto is a Python package that provides interfaces to Amazon Web Services (AWS)
- In this example, a connection to EC2 service is first established by calling boto.ec2.connect_to_region.
- The EC2 region, AWS access key and AWS secret key are passed to this function. After connecting to EC2 , a new instance is launched using the conn.run_instances function.
- The AMI-ID, instance type, EC2 key handle and security group are passed to this function.

```
#Python program for launching an EC2 instance
import boto3
ACCESS_KEY = "<enter access key>"
SECRET_KEY = "<enter secret key>"
REGION = "us-east-1"
ec2 = boto3.resource('ec2',
   region_name=REGION,
   aws_access_key_id=ACCESS_KEY,
   aws_secret_access_key=SECRET_KEY
) instances = ec2.create_instances(
   ImageId='ami-0c02fb55956c7d316',
   MinCount=1,   MaxCount=1,   InstanceType='t2.micro',
   KeyName='<enter key handle>',
   SecurityGroups=['default’]
) instance = instances[0]
print("Instance ID:", instance.id)
```

Amazon AutoScaling – Python Example

- AutoScaling Service
  - A connection to AutoScaling service is first established by calling boto.ec2.autoscale.connect_to_region function.
- Launch Configuration
  - After connecting to AutoScaling service, a new launch configuration is created by calling conn.create_launch_con figuration. Launch configuration contains instructions on how to launch new instances including the AMI-ID, instance type, security groups, etc.
- AutoScaling Group
  - After creating a launch configuration, it is then associated with a new AutoScaling group. AutoScaling group is created by calling conn.create_auto_scaling_group. The settings for AutoScaling group such as the maximum and minimum number of instances in the group, the launch configuration, availability zones, optional load balancer to use with the group, etc.

#Python program for creating an AutoScaling group (code excerpt)

```
import boto.ec2.autoscale
:
print "Connecting to Autoscaling Service"
conn = boto.ec2.autoscale.connect_to_region(REGION,
  aws_access_key_id=ACCESS_KEY, aws_secret_access_key=SECRET_KEY)

print "Creating launch configuration"

lc = LaunchConfiguration(name='My-Launch-Config-2',
      image_id=AMI_ID, key_name=EC2_KEY_HANDLE,
      instance_type=INSTANCE_TYPE, security_groups = [ SECGROUP_HANDLE,
      ])
conn.create_launch_configuration(lc)

print "Creating auto-scaling group"

 ag = AutoScalingGroup(group_name='My-Group',
                availability_zones=['us-east-1b'],
                launch_config=lc, min_size=1, max_size=2,
                connection=conn)
conn.create_auto_scaling_group(ag)
```

Amazon AutoScaling – Python Example

- AutoScaling Policies
  - After creating an AutoScaling group, the policies for scaling up and scaling down are defined.
  - In this example, a scale up policy with adjustment type ChangeInCapacity and scaling_ad justment = 1 is defined.
  - Similarly a scale down policy with adjustment type ChangeInCapacity and scaling_ad justment = -1 is defined.

```
#Creating auto-scaling policies

scale_up_policy = ScalingPolicy(name='scale_up',
                                adjustment_type='ChangeIn
                                Capacity', as_name='My-
                                Group',
                                scaling_adjustment=1,
                                cooldown=180)

scale_down_policy =
ScalingPolicy(name='scale_down',
                                adjustment_type='ChangeIn
                        Capacity', as_name='My-Group',
                                scaling_adjustme
                                nt=-1,
                                cooldown=180)


conn.create_scaling_policy(scale_u
p_policy)
conn.create_scaling_policy(scale_d
own_policy)
```

Amazon S3- Core Architecture: Buckets and Objects

1. Bucket: A container for objects.
Global Namespace: Bucket names must be unique across all AWS accounts worldwide (like a DNS name).
Region Specific: You create a bucket in a specific region (e.g., us-east-1), and your data never leaves that region unless you explicitly move it.
2. Object: The fundamental entity stored in S3.
Key: The name of the object (e.g., photos/vacation.jpg).
Value: The data itself (bytes).
Metadata: Name-value pairs describing the object (e.g., Content-Type: image/jpeg).
Size: Objects can be from 0 bytes up to 5 Terabytes.

Amazon S3 – Python Example

- In this example, a connection to S3 service is first established by calling boto.connect_s3 function.
- The upload_to_s3_bucket_path function uploads the file to the S3 bucket specified at the specified path.

```
# Python program for uploading a file to an S3 bucket
import boto.s3

conn = boto.connect_s3(aws_access_key_id='<enter>',
   aws_secret_access_key='<enter>')

def percent_cb(complete, total): print ('.')

def upload_to_s3_bucket_path(bucketname, path, filename):
        mybucket = conn.get_bucket(bucketname)
        fullkeyname=os.path.join(path,filename)
        key = mybucket.new_key(fullkeyname)
        key.set_contents_from_filename(filename, cb=percent_cb, num_cb=10)
```

Amazon RDS – Python Example

- In this example, a connection to RDS service is first established by calling boto.rds.connect_to_region function.
- The RDS region, AWS access key and AWS secret key are passed to this function.
- After connecting to RDS service, the conn.create_dbinstance function is called to launch a new RDS instance.
- The input parameters to this function include the instance ID, database size, instance type, database username, database password, database port, database engine (e.g. MySQL5.1), database name, security groups, etc.

```
#Python program for launching an RDS instance (excerpt)
import boto.rds
ACCESS_KEY="<enter>" SECRET_KEY="<enter>"
REGION="us-east-1" INSTANCE_TYPE="db.t1.micro" ID =
"MySQL-db-instance-3" USERNAME = 'root'
PASSWORD =
'password' DB_PORT
= 3306
DB_SIZE = 5
DB_ENGINE = 'MySQL5.1'
DB_NAME = 'mytestdb'
SECGROUP_HANDLE="de
fault"

#Connecting to RDS
conn =
  boto.rds.connect_to_region(REGION,
  aws_access_key_id=ACCESS_KEY,
  aws_secret_access_key=SECRET_KEY)


#Creating an RDS instance
db = conn.create_dbinstance(ID, DB_SIZE,
INSTANCE_TYPE, USERNAME, PASSWORD,
port=DB_PORT, engine=DB_ENGINE,
db_name=DB_NAME, security_groups = [
SECGROUP_HANDLE, ] )
```

Amazon DynamoDB – Python Example

- In this example, a connection to DynamoDB service is first established by calling boto.dynamodb.connect_to_region.
- After connecting to DynamoDB service, a schema for the new table is created by calling conn.create_schema.
- The schema includes the hash key and range key names and types.
- A DynamoDB table is then created by calling conn.create_table function with the table schema, read units and write units as input parameters.

```
# Python program for creating a DynamoDB table (excerpt)
import boto.dynamodb

ACCESS_KEY="<ente
r>"
SECRET_KEY="<ente
r>"       REGION="us-
east-1"

#Connecting to DynamoDB
conn =
  boto.dynamodb.connect_to_region(REGIO
  N, aws_access_key_id=ACCESS_KEY,
  aws_secret_access_key=SECRET_KEY)

table_schema =
      conn.create_schema(
      hash_key_name='msgid',
      hash_key_proto_value=str,
      range_key_name='date',
      range_key_proto_value=str
   )

#Creating table with schema
table =
      conn.create_table(
      name='my-test-
      table',
      schema=table_sche
      ma, read_units=1,
      write_units=1
   )
```

Google Compute Engine – Python Example

- This example uses the OAuth 2.0 scope (https://www.googleapis.com/auth/compute) and credentials in the credentials file to request a refresh and access token, which is then stored in the oauth2.dat file.
- After completing the OAuth authorization, an instance of the Google Compute Engine service is obtained.
- To launch a new instance the instances().insert method of the Google Compute Engine API is used.
- The request body to this method contains the properties such as instance name, machine type, zone, network interfaces, etc., specified in JSON format.

```
# Python program for launching a GCE instance (excerpt)
API_VERSION = 'v1beta15'
GCE_SCOPE = 'https://www.googleapis.com/auth/compute'
GCE_URL = 'https://www.googleapis.com/compute/%s/projects/' % (API_VERSION)
DEFAULT_ZONE = 'us-central1-b'
CLIENT_SECRETS = 'client_secrets.json'
OAUTH2_STORAGE = 'oauth2.dat'

def main():
  #OAuth 2.0 authorization.
  flow = flow_from_clientsecrets(CLIENT_SECRETS, scope=GCE_SCOPE)
  storage = Storage(OAUTH2_STORAGE)
  credentials = storage.get()

  if credentials is None or credentials.invalid:
    credentials = run(flow, storage)
  http = httplib2.Http()
  auth_http = credentials.authorize(http)

  gce_service = build('compute', API_VERSION)

# Create the instance
  request = gce_service.instances().insert(project=PROJECT_ID, body=instance,
                                           zone=DEFAULT_ZONE)
  response = request.execute(auth_http)
```

Google Cloud Storage – Python Example

- This example uses the Oauth 2.0 scope (https://www.googleapis.com/auth/devstorage.full_control) and credentials in the credentials file to request a refresh and access token, which is then stored in the oauth2.dat file.
- After completing the OAuth authorization, an instance of the Google Cloud Storage service is obtained.
- To upload a file the objects().insert method of the Google Cloud Storage API is used.
- The request to this method contains the bucket name, file name and media body containing the MediaIoBaseUpload object created from the file contents.

```
# Python program for uploading a file to GCS (excerpt)

def main():
  #OAuth 2.0 authorization.
  flow = flow_from_clientsecrets(CLIENT_SECRETS, scope=GS_SCOPE)
  storage = Storage(OAUTH2_STORAGE)
  credentials = storage.get()

  if credentials is None or credentials.invalid:
    credentials = run(flow, storage)
  http = httplib2.Http()
  auth_http = credentials.authorize(http)

  gs_service = build('storage', API_VERSION, http=auth_http)

# Upload file
  fp= open(FILENAME,'r')
  fh = io.BytesIO(fp.read())
  media = MediaIoBaseUpload(fh, FILE_TYPE)
   request = gs_service.objects().insert(bucket=BUCKET, name=FILENAME,
                                         media_body=media)
  response = request.execute()
```

Google Cloud SQL – Python Example

- This example uses the OAuth 2.0 scope (https://www.googleapis.com/auth/compute) and credentials in the credentials file to request a refresh and access token, which is then stored in the oauth2.dat file.
- After completing the OAuth authorization, an instance of the Google Cloud SQL service is obtained.
- To launch a new instance the instances().insert method of the Google Cloud SQL API is used.
- The request body of this method contains properties such as instance, project, tier, pricingPlan and replicationType.

```
# Python program for launching a Google Cloud SQL instance (excerpt)

def main():
  #OAuth 2.0 authorization.
  flow = flow_from_clientsecrets(CLIENT_SECRETS, scope=GS_SCOPE)
  storage = Storage(OAUTH2_STORAGE)
  credentials = storage.get()

  if credentials is None or credentials.invalid:
    credentials = run(flow, storage)
  http = httplib2.Http()
  auth_http = credentials.authorize(http)

  gcs_service = build('sqladmin', API_VERSION, http=auth_http)

  # Define request body
 instance={"instance": "mydb",
 "project": "bahgacloud",
 "settings":{
    "tier": "D0",
    "pricingPlan": "PER_USE",
    "replicationType": "SYNCHRONOUS"}}

 # Create the instance
  request = gcs_service.instances().insert(project=PROJECT_ID, body=instance)
  response = request.execute()
```

Azure Storage – Python Example

- Azure Blobs service allows you to store large amounts of unstructured text or binary data such as video, audio and images.
- This shows an example of using the Blob service for storing a file.
- Blobs are organized in containers. The create_container method is used to create a new container.
- After creating a container the blob is uploaded using the put_blob method.
- Blobs can be listed using the list_blobs method.
- To download a blob, the get_blob method is used.

```
# Python example of using Azure Blob Service (excerpt)

from azure.storage import *
blob_service = BlobService(account_name='enter', account_key='<enter>')

#Create Container
blob_service.create_container('mycontainer')

#Upload Blob
filename='images.txt'
myblob = open(filename, 'r').read()
blob_service.put_blob('mycontainer', filename, myblob,
x_ms_blob_type='BlockBlob')

#List Blobs
blobs = blob_service.list_blobs('mycontainer')
for blob in blobs:
    print(blob.name)
    print(blob.url)

#Download Blob
output_filename='output.txt'
blob = blob_service.get_blob('mycontainer', 'myblob')
with open(output_filename, 'w') as f:
    f.write(blob)
```

Python for MapReduce

- The example shows inverted index mapper program.
- The map function reads the data from the standard input (stdin) and splits the tab-limited data into document-ID and contents of the document.
- The map function emits key-value pairs where key is each word in the document and value is the document-ID.

```
#Inverted Index Mapper in Python
#!/usr/bin/env python import sys
for line in sys.stdin:
doc_id, content = line.split(’’)
words = content.split()
for word in words:
print ’%s%s’ % (word, doc_id)
```

Python Packages of Interest

- JSON
  - JavaScript Object Notation (JSON) is an easy to read and write data-interchange format.
  - JSON is used as an alternative to XML and is is easy for machines to parse and generate.
  - JSON is built on two structures - a collection of name-value pairs (e.g. a Python dictionary) and ordered lists of values (e.g.. a Python list).

  - import json

```
data = {"name": "Ajitha", "age": 20}
json_string = json.dumps(data)
print(json_string)
```

- XML
  - XML (Extensible Markup Language) is a data format for structured document interchange.
  - The Python minidom library provides a minimal implementation of the Document Object Model interface and has an API similar to that in other languages.
  - from xml.dom import minidom

    doc = minidom.parse("file.xml")

    print(doc.getElementsByTagName("name")[0].firstChild.data)

- HTTPLib & URLLib
    - HTTPLib2 and URLLib2 are Python libraries used in network/internet programming

URLLib

Used to fetch URLs (web pages, APIs).

- import urllib.request

- response = urllib.request.urlopen("https://example.com")
- print(response.read())

HTTPLib (http.client in Python 3)

Used for HTTP protocol operations.

```
import http.client
conn = http.client.HTTPSConnection("example.com")
conn.request("GET", "/")
res = conn.getresponse()
print(res.status)
```

- SMTPLib
  - Simple Mail Transfer Protocol (SMTP) is a protocol which handles sending email and routing e-mail between mail servers. The Python smtplib module provides an SMTP client session object that can be used to send email.

```
import smtplib
server = smtplib.SMTP('smtp.gmail.com', 587)
server.starttls()
server.login("your_email@gmail.com", "password")
server.sendmail("your_email@gmail.com", "receiver@gmail.com", "Hello")
server.quit()
```

- NumPy
    - NumPy is a package for scientific computing in Python. NumPy provides support for large multi-dimensional arrays and matrices

```
import numpy as np
arr = np.array([1, 2, 3, 4])
print(arr.mean())
```

- Scikit-learn
  - Scikit-learn is an open source machine learning library for Python that provides implementations of various machine learning algorithms for classification, clustering, regression and dimension reduction problems.

```
from sklearn.linear_model import LinearRegression
import numpy as np
X = np.array([[1], [2], [3]])
y = np.array([2, 4, 6])
model = LinearRegression()
model.fit(X, y)
print(model.predict([[4]]))
```

Python Web Application Framework - Django

- Django is a **high-level Python web framework** used to build secure, scalable, and maintainable web applications quickly.
- Django helps developers build:
  - Websites
  - Web applications
  - REST APIs
  - Admin dashboards
- Django follows **MVT (Model–View–Template)** architecture.

Component	Purpose
Model	Handles database
View	Contains business logic
Template	Controls frontend (HTML)

Key Features of Django

✓ Built-in Admin Panel
✓ ORM (Object Relational Mapping)
✓ Authentication System
✓ URL Routing
✓ Form Handling
✓ Security (CSRF, SQL Injection protection)
✓ Scalable & Fast Development

•Basic Steps to Create Django Project

```
pip install django

django-admin startproject myproject

cd myproject

python manage.py runserver
```

Django	Flask
Full-featured framework	Lightweight framework
Built-in admin	No built-in admin
Large projects	Small projects
MVT architecture	Flexible structure

Cloud Application Development in Python

Outline

- Design methodology for IaaS service model
- Design methodology for PaaS service model
- Cloud application case studies including:
  - Image Processing App
  - Document Storage App
  - MapReduce App
  - Social Media Analytics App

Design methodology for IaaS service model

Component Design

- Indentify the building blocks of the application and to be performed by each block
- Group the building blocks based on the functions performed and type of cloud resources required and identify the application components based on the groupings
- Identify the inputs and outputs of each component
- List the interfaces that each component will expose
- Evaluate the implementation alternatives for each component (design patterns such as MVC, etc.)

Architecture Design

- Define the interactions between the application components
- Guidelines for loosely coupled and stateless designs - use messaging queues (for asynchronous communication), functional interfaces (such as REST for loose coupling) and external status database (for stateless design)

Deployment Design

- Map the application components to specific cloud resources (such as web servers, application servers, database servers, etc.)

Design methodology for PaaS service model

- For applications that use the Platform-as-a-service (PaaS) cloud service model, the architecture and deployment design steps are not required since the platform takes care of the architecture and deployment.
- Component Design
  - In the component design step, the developers have to take into consideration the platform specific features.
- Platform Specific Software
  - Different PaaS offerings such as Google App Engine, Windows Azure Web Sites, etc., provide platform specific software development kits (SDKs) for developing cloud applications.
- Sandbox Environments
  - Applications designed for specific PaaS offerings run in sandbox environments and are allowed to perform only those actions that do not interfere with the performance of other applications.
- Deployment & Scaling
  - The deployment and scaling is handled by the platform while the developers focus on the application development using the platform-specific SDKs.
- Portability
  - Portability is a major constraint for PaaS based applications as it is difficult to move the

Image Processing App – Component Design

- Functionality:
  - A cloud-based Image Processing application.
  - This application provides online image filtering capability.
  - Users can upload image files and choose the filters to apply.
  - The selected filters are applied to the image and the processed image can then be downloaded.

- Component Design
  - **Web Tier:** The web tier for the image processing app has front ends for image submission and displaying processed images.
  - **Application Tier:** The application tier has components for processing the image submission requests, processing the submitted image and processing requests for displaying the results.
  - **Storage Tier:** The storage tier comprises of the storage for processed images.

Component design for Image Processing App

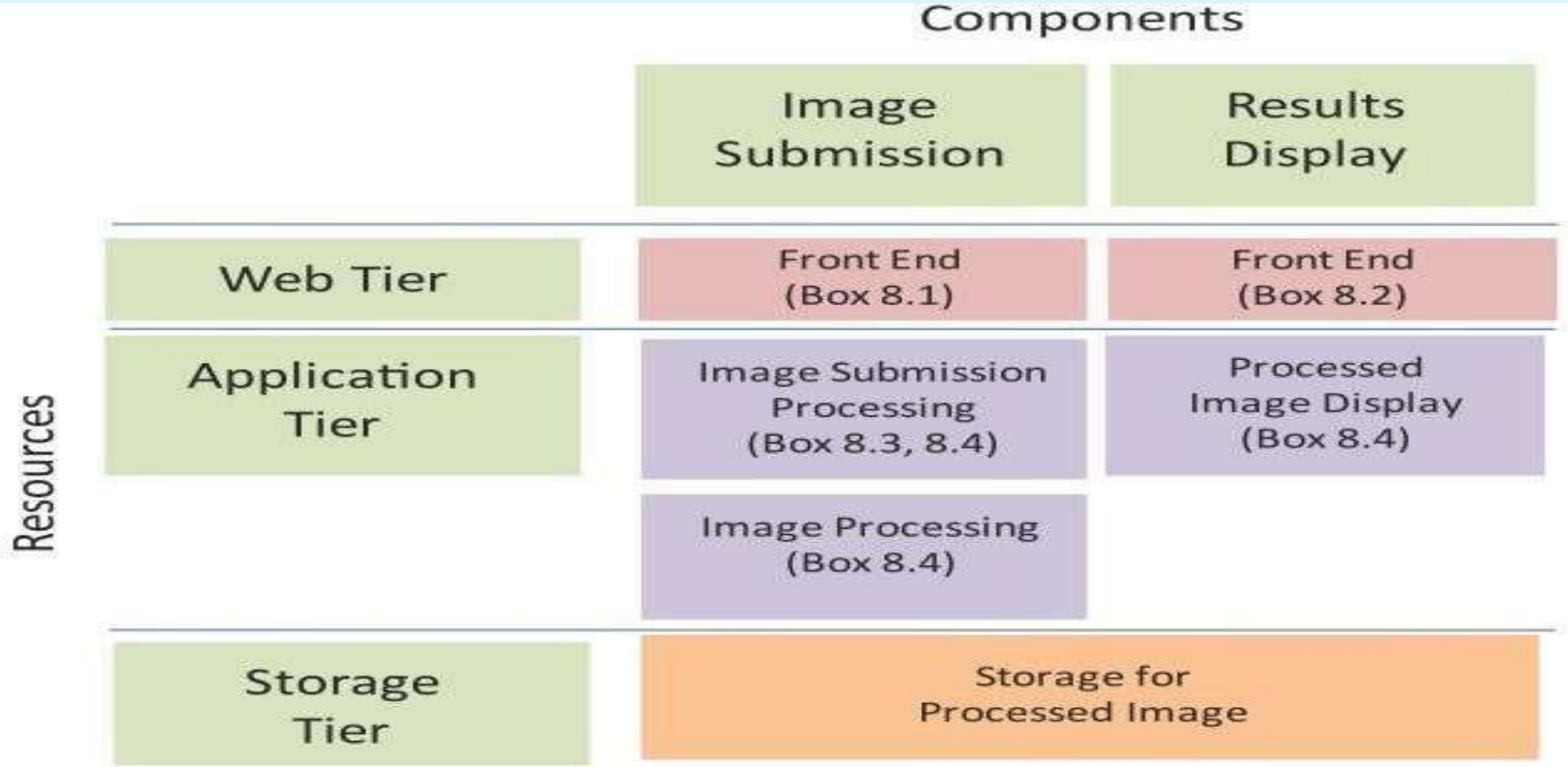


Image Processing App – Architecture Design

- Architecture design step which defines the interactions between the application components.
- This application uses the Django framework, therefore, the web tier components map to the Django templates and the application tier components map to the Django views.
- A cloud storage is used for the storage tier. For each component, the corresponding code box numbers are mentioned.

Architecture design for Image Processing App

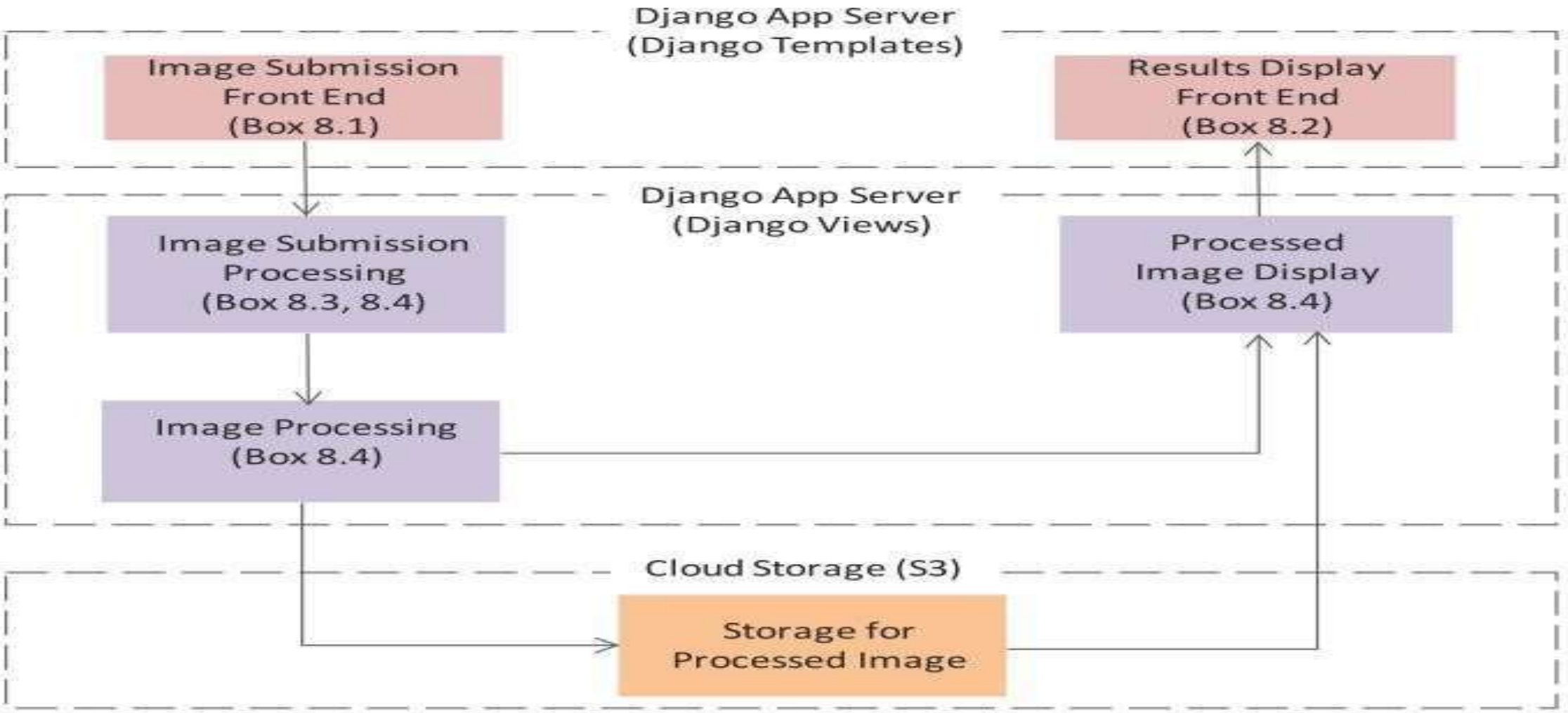
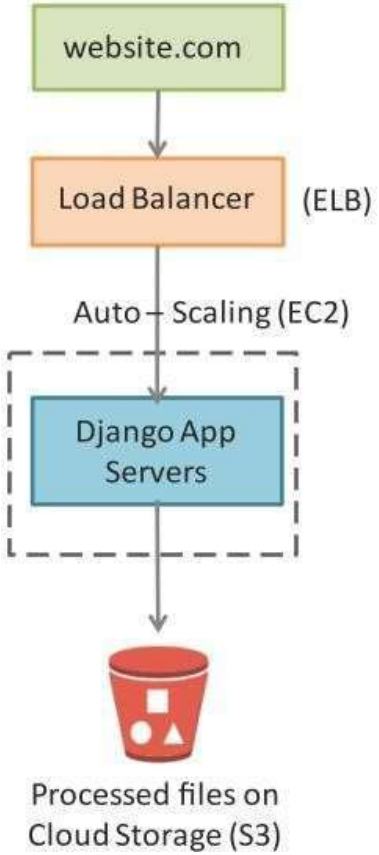


Image Processing App – Deployment Design

- Deployment for the app is a multi-tier architecture comprising of load balancer, application servers and a cloud storage for processed images.
- For each resource in the deployment the corresponding Amazon Web Services (AWS) cloud service is mentioned.

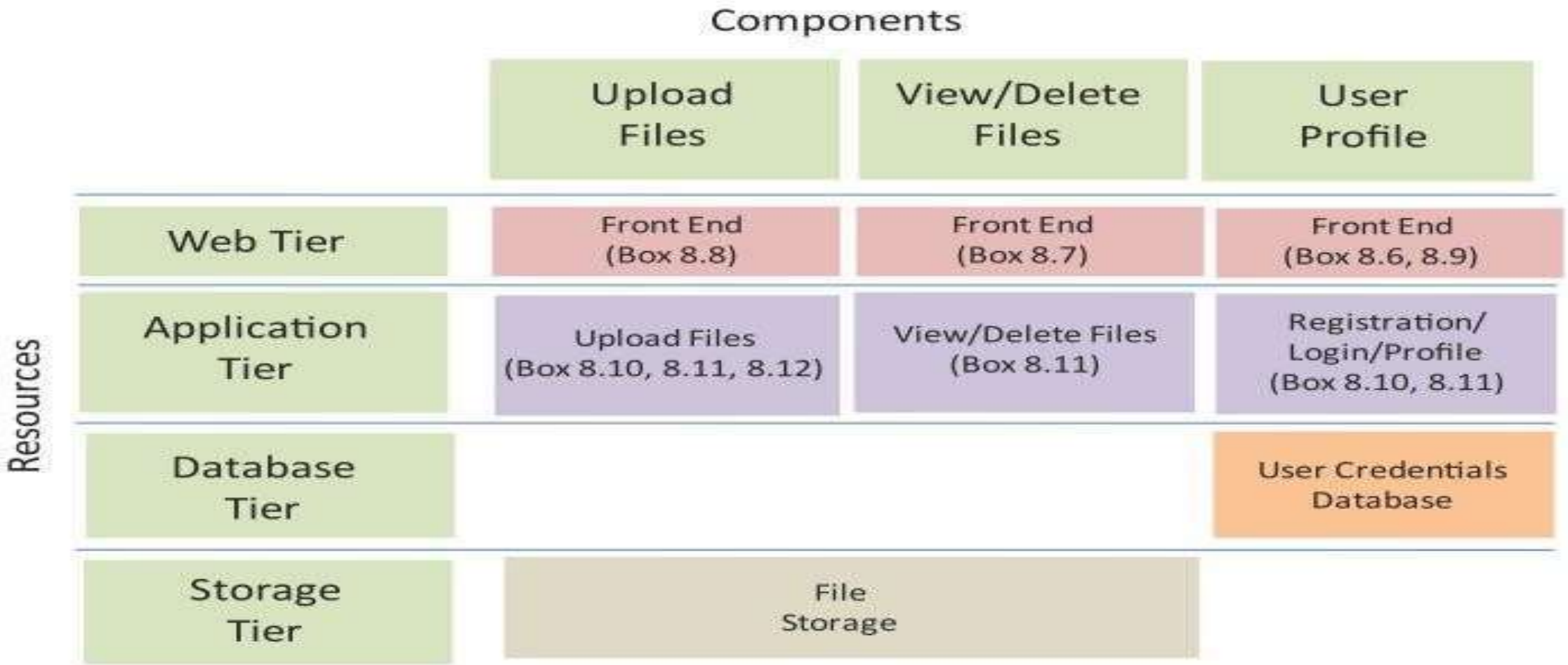
Deployment design for Image Processing App



Cloud Drive App – Component Design

- Functionality:
  - A cloud-based document storage (Cloud Drive) application.
  - This application allows users to store documents on a cloud- based storage.
- Component Design
  - **Web Tier:** The web tier for the Cloud Drive app has front ends for uploading files, viewing/deleting files and user profi le.
  - **Application Tier:** The application tier has components for processing requests for uploading files, processing requests for viewing/deleting files and the component that handles the registration, profile and login functions.
  - **Database Tier:** The database tier comprises of a user credentials database.
  - **Storage Tier:** The storage tier comprises of the storage for fi les.

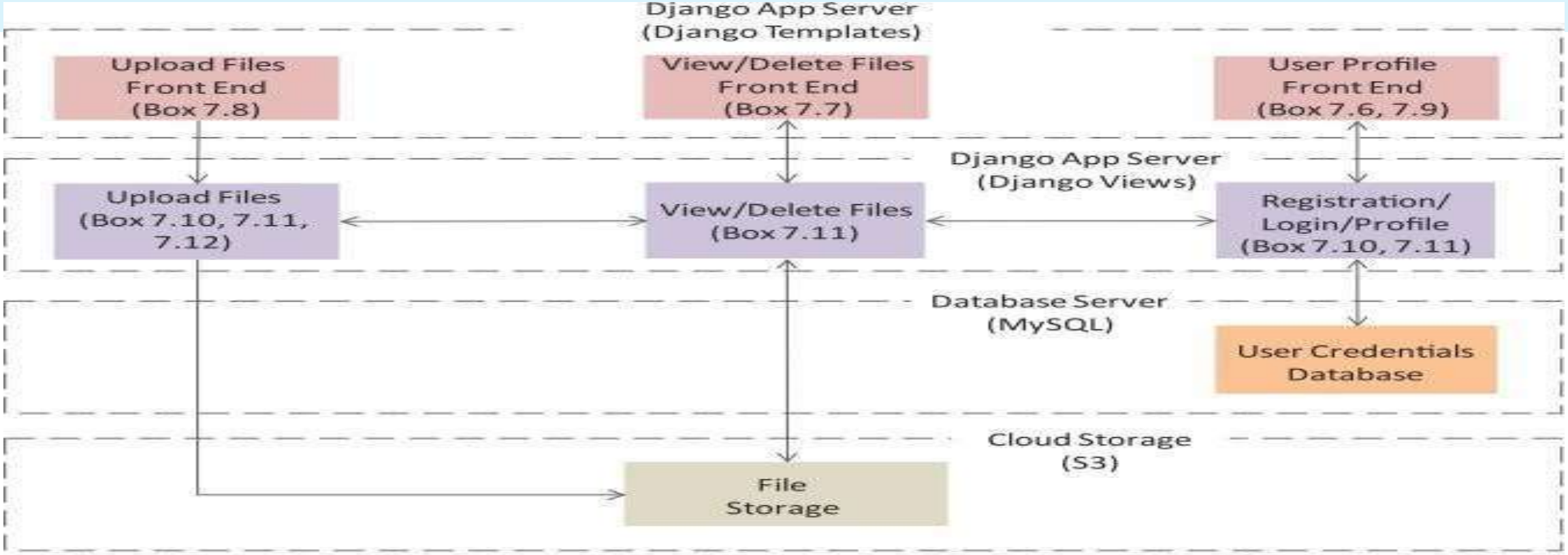
Component design for Cloud Drive App



Cloud Drive App – Architecture Design

- Architecture design step which defines the interactions between the application components.
- This application uses the Django framework, therefore, the web tier components map to the Django templates and the application tier components map to the Django views.
- A MySQL database is used for the database tier and a cloud storage is used for the storage tier.
- For each component, the corresponding code box numbers are mentioned.

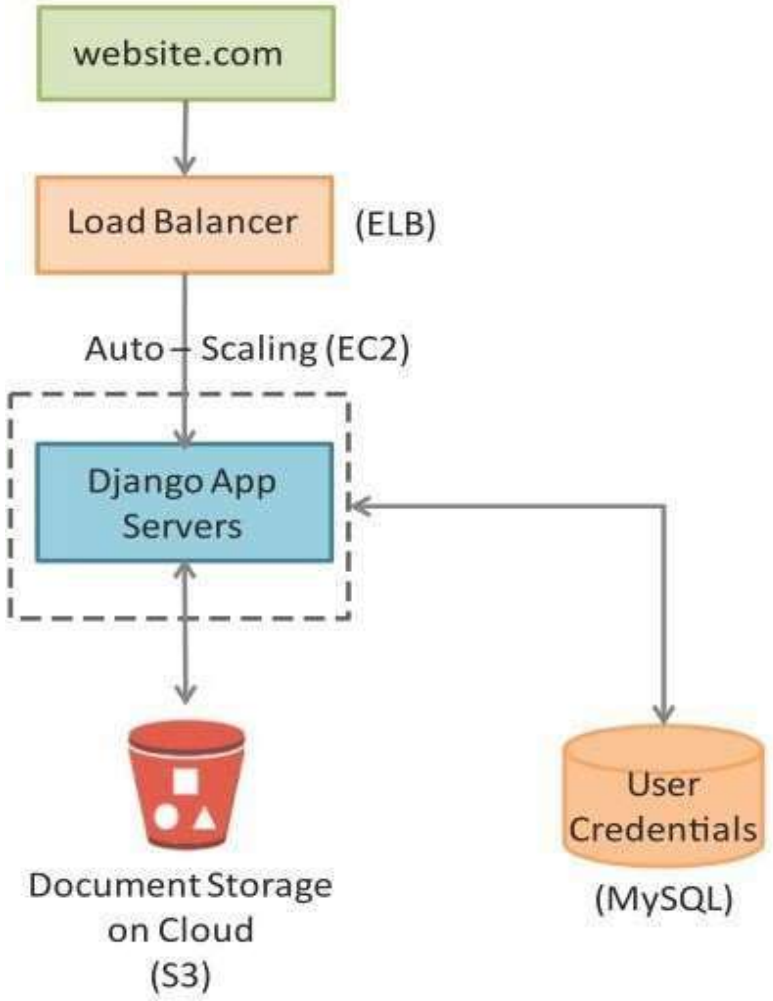
Architecture design for Cloud Drive App



Cloud Drive App – Deployment Design

- Deployment for the app is a multi-tier architecture comprising of load balancer, application servers, cloud storage for storing documents and a database server for storing user credentials.
- For each resource in the reference architecture the corresponding Amazon Web Services (AWS) cloud service is mentioned.

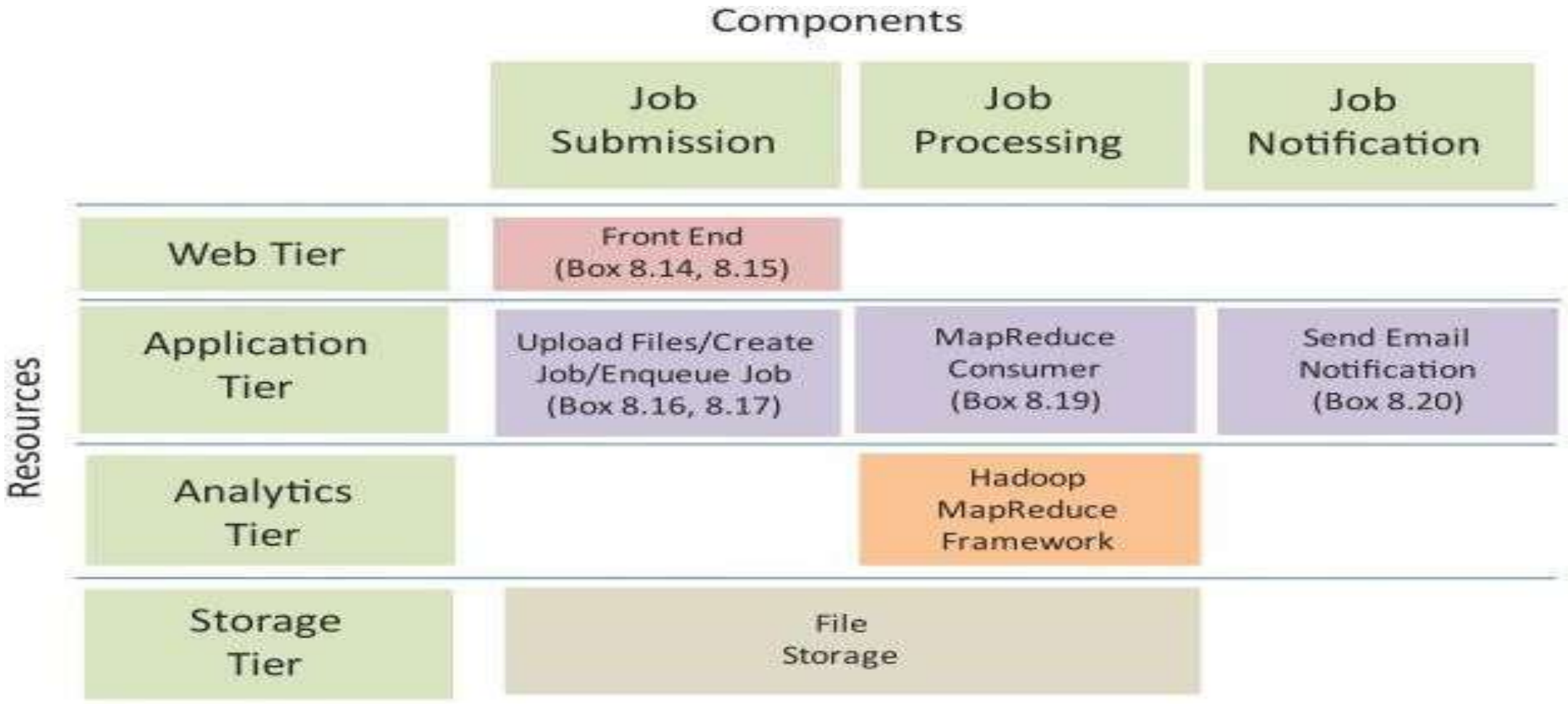
Deployment design for Cloud Drive App



MapReduce App – Component Design

- Functionality:
  - This application allows users to submit MapReduce jobs for data analysis.
  - This application is based on the Amazon Elastic MapReduce (EMR) service.
  - Users can upload data files to analyze and choose/upload the Map and Reduce programs.
  - The selected Map and Reduce programs along with the input data are submitted to a queue for processing.
- Component Design
  - **Web Tier:** The web tier for the MapReduce app has a front end for MapReduce job submission.
  - **Application Tier:** The application tier has components for processing requests for uploading files, creating MapReduce jobs and enqueuing jobs, MapReduce consumer and the component that sends email noti fications.
  - **Analytics Tier:** The Hadoop framework is used for the analytics tier and a cloud storage is used for the storage tier.
  - **Storage Tier:** The storage tier comprises of the storage for files.

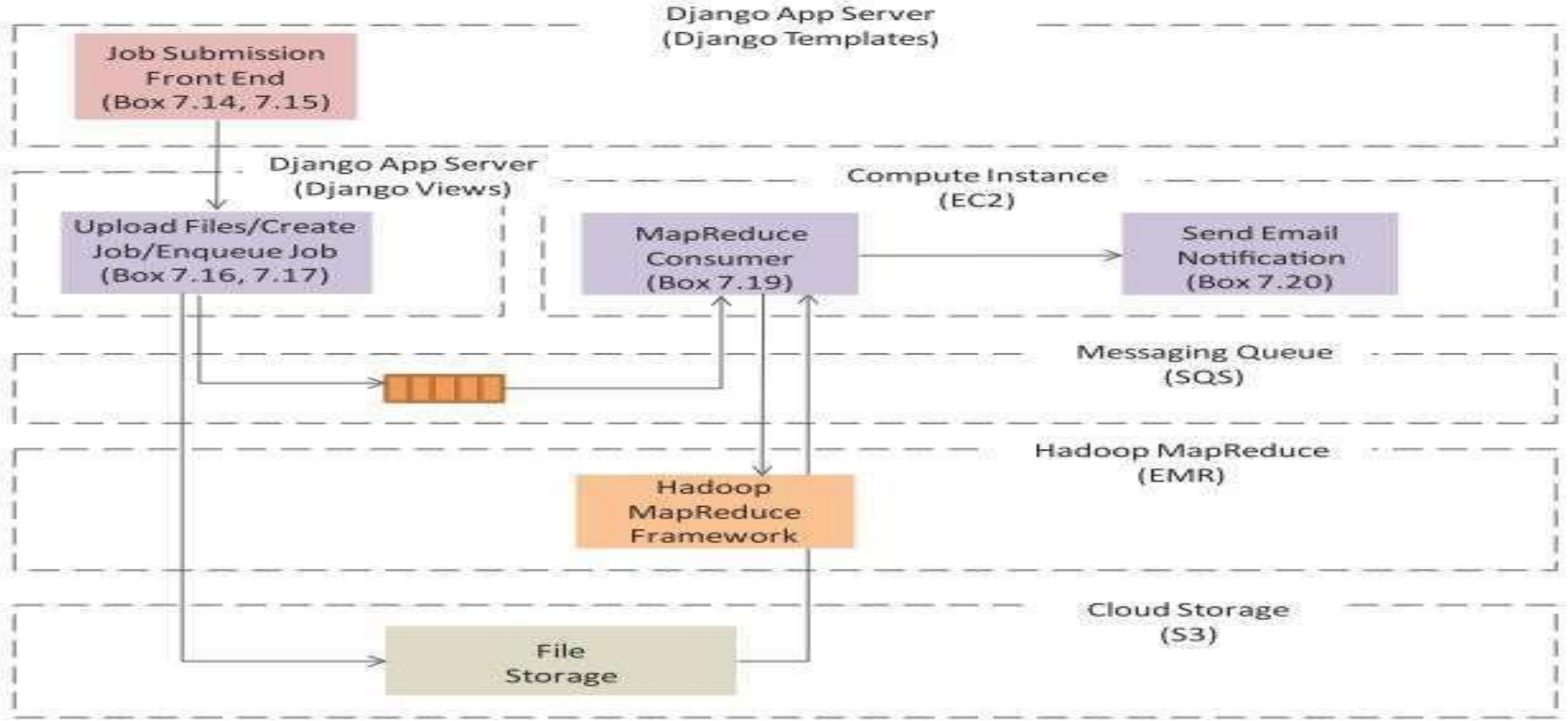
Component design for MapReduce App



MapReduce App – Architecture Design

- Architecture design step which defines the interactions between the application components.
- This application uses the Django framework, therefore, the web tier components map to the Django templates and the application tier components map to the Django views.
- For each component, the corresponding code box numbers are mentioned.
- To make the application scalable the job submission and job processing components are separated.
- The MapReduce job requests are submitted to a queue.
- A consumer component that runs on a separate instance retrieves the MapReduce job requests from the queue and creates the MapReduce jobs and submits them to the Amazon EMR service.
- The user receives an email notification with the download link for the results when the job is complete.

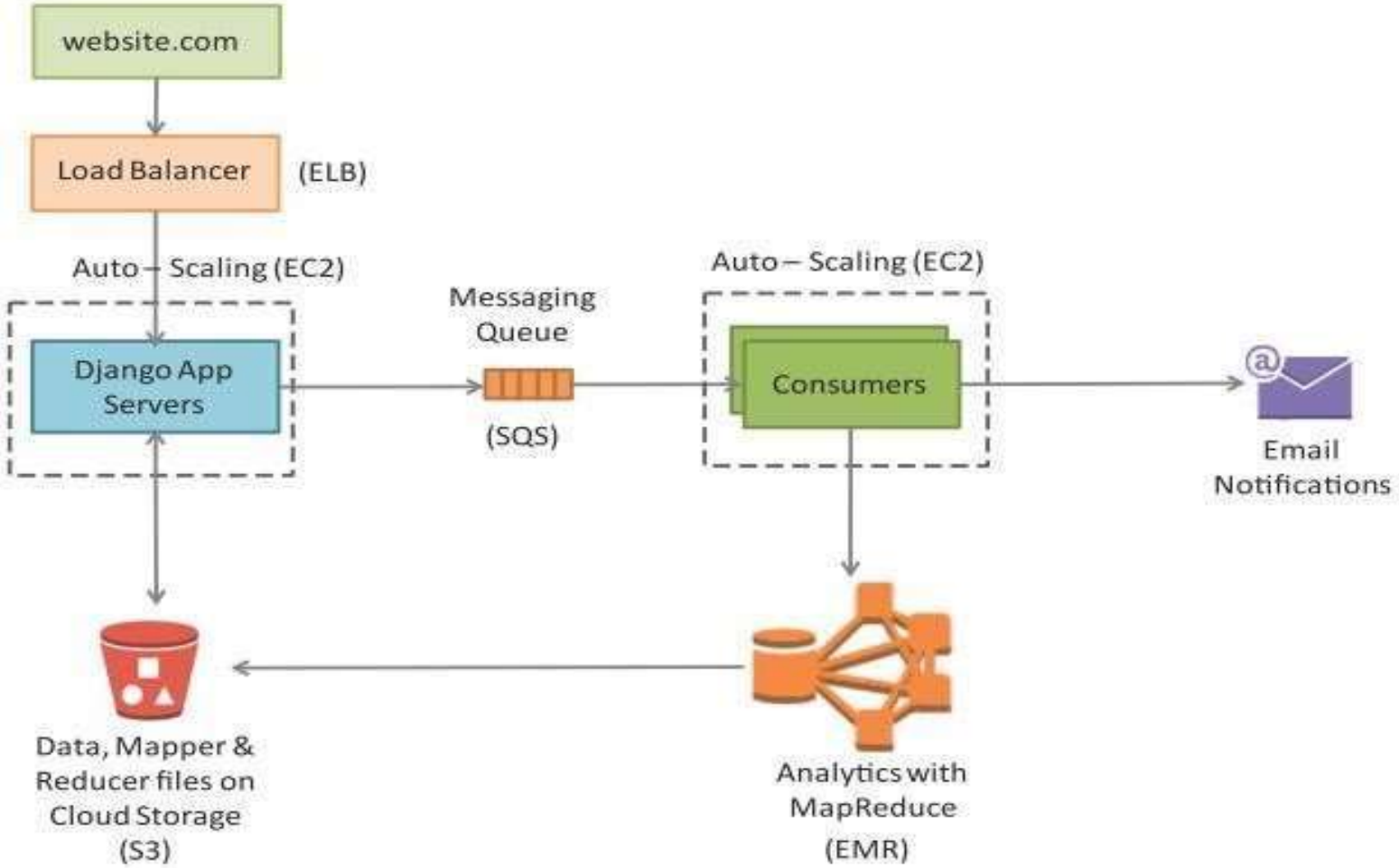
Architecture design for MapReduce App



MapReduce App – Deployment Design

- Deployment for the app is a multi-tier architecture comprising of load balancer, application servers and a cloud storage for storing MapReduce programs, input data and MapReduce output.
- For each resource in the deployment the corresponding Amazon Web Services (AWS) cloud service is mentioned.

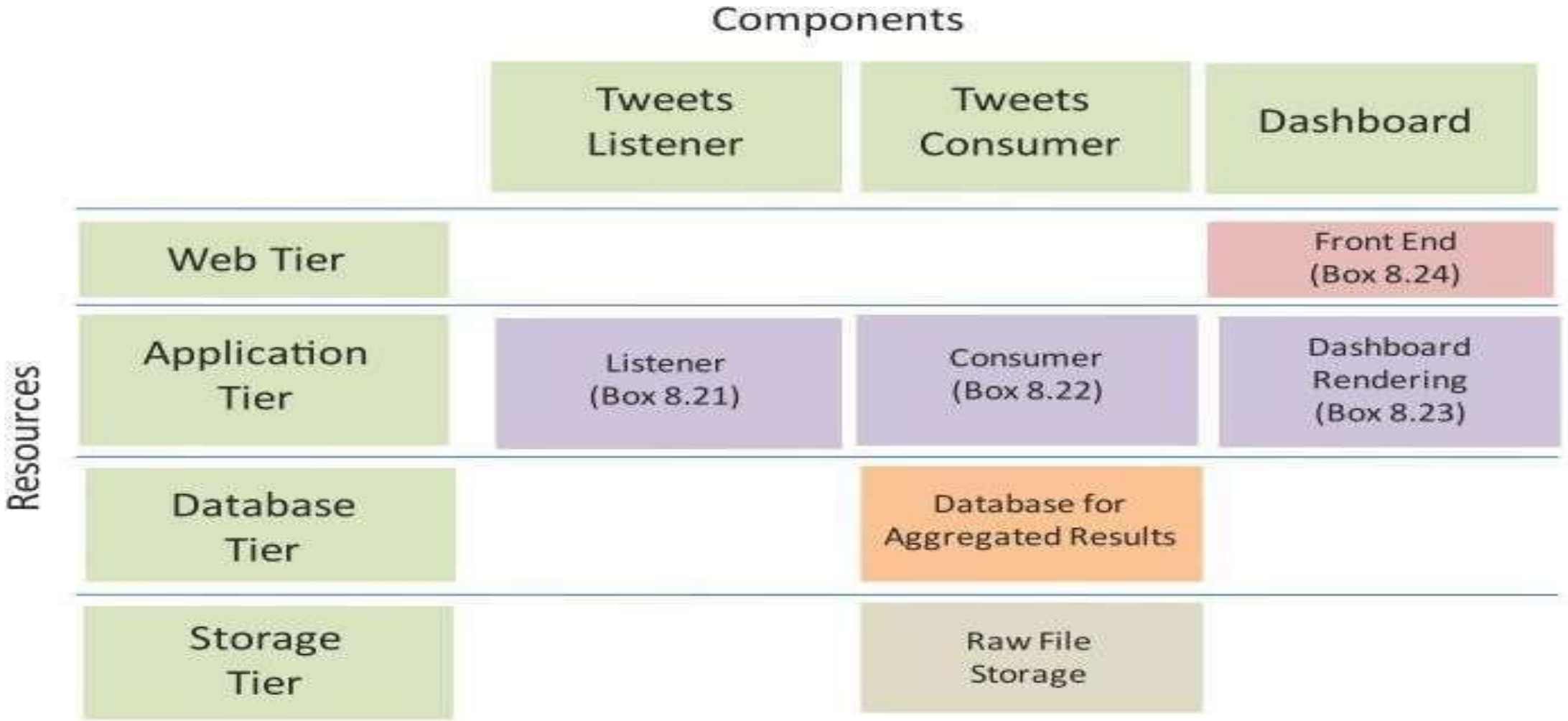
Deployment design for MapReduce App



Social Media Analytics App – Component Design

- Functionality:
  - A cloud-based Social Media Analytics application.
  - This application collects the social media feeds (Twitter tweets) on a specified keyword in real time and analyzes the sentiments of the tweets and provides aggregate results.
- Component Design
  - **Web Tier:** The web tier has a front end for displaying results.
  - **Application Tier:** The application tier has a listener component that collects social media feeds, a consumer component that analyzes tweets and a component for rendering the results in the dashboard.
  - **Database Tier:** A MongoDB database is used for the database tier and a cloud storage is used for the storage tier.
  - **Storage Tier:** The storage tier comprises of the storage for files.

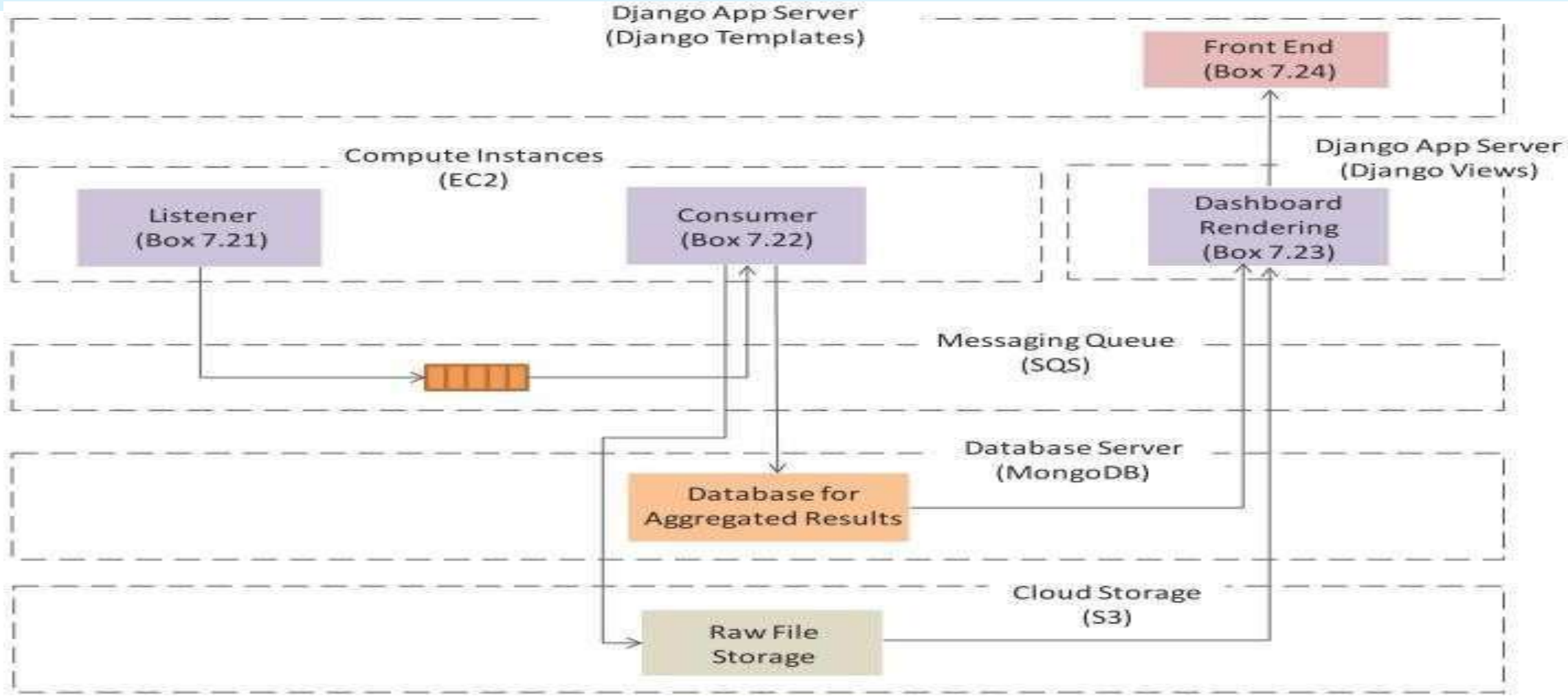
Component design for Social Media Analytics App



Social Media Analytics App – Architecture Design

- Architecture design step which defines the interactions between the application components.
- To make the application scalable the feeds collection component (Listener) and feeds processing component (Consumer) are separated.
- The Listener component uses the Twitter API to get feeds on a specific keyword (or a list of keywords) and enqueues the feeds to a queue.
- The Consumer component (that runs on a separate instance) retrieves the feeds from the queue and analyzes the feeds and stores the aggregated results in a separate database.
- The aggregate results are displayed to the users from a Django application.

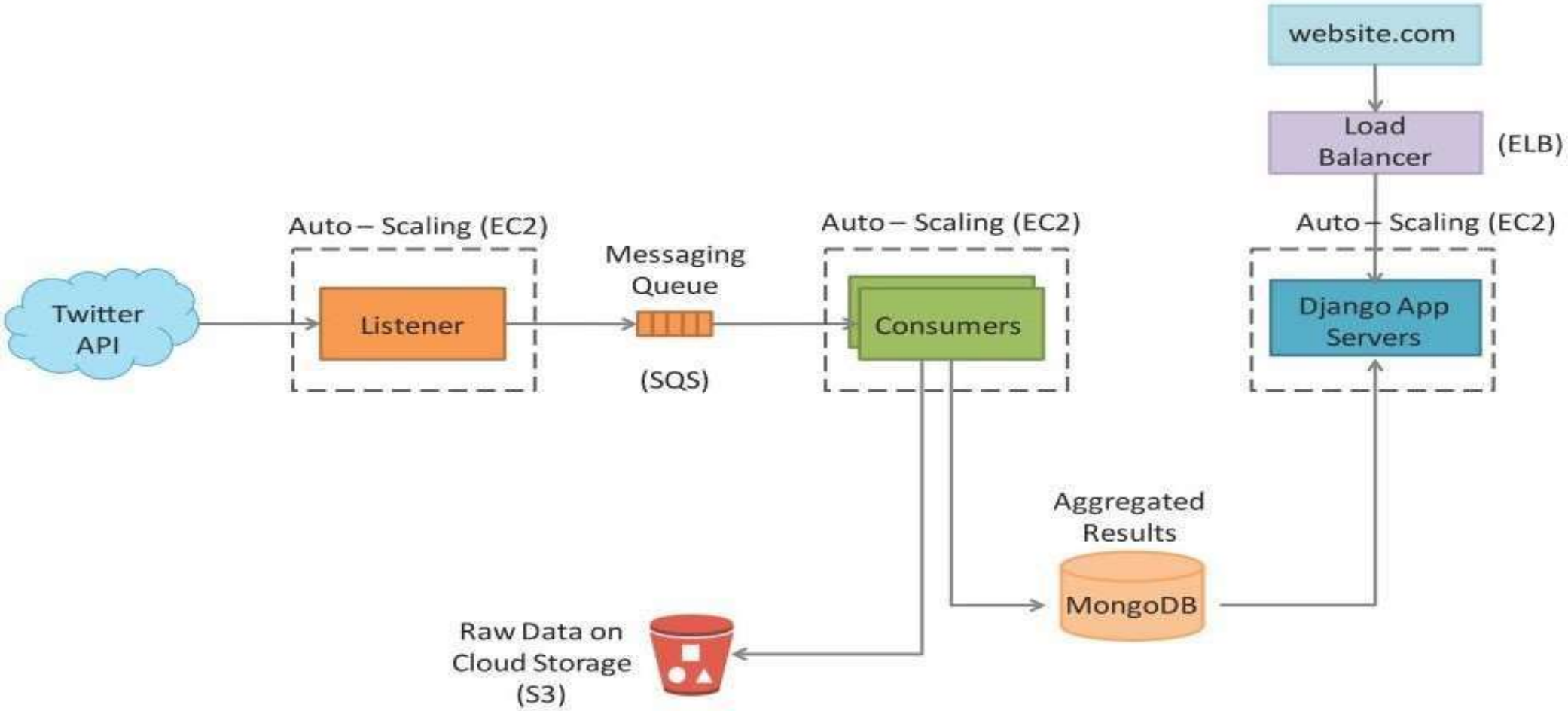
Architecture design for Social Media Analytics App



Social Media Analytics App – Deployment Design

- Deployment for the app is a multi-tier architecture comprising of load balancer, application servers, listener and consumer instances, a cloud storage for storing raw data and a database server for storing aggregated results.
- For each resource in the deployment the corresponding Amazon Web Services (AWS) cloud service is mentioned.

Deployment design for Social Media Analytics App



Social Media Analytics App – Dashboard